bart
impact
program

# ENVIRONMENTAL IMPACTS OF BART
# THE USER'S EXPERIENCE



technical memorandum

The BART Impact Program is a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program is being conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program is financed by the U.S. Department of Transportation, the U.S. Department of Housing and Urban Development, and the California Department of Transportation. Management of the Federally funded portion of the program is vested in the U.S. Department of Transportation.

The BART Impact Program covers the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors will be measured and analyzed. The benefits of BART, and their distribution, will be weighed against the negative impacts and costs of the system in an objective evaluation of the contribution that the rapid transit investment makes toward meeting the needs and objectives of this metropolitan area and all of its people.

DOCUMENT NO. DOT-BIP-TM 23-4-77

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BART IMPACT PROGRAM

# ENVIRONMENTAL IMPACTS OF BART
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JULY 1977

TECHNICAL MEMORANDUM



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PREPARED FOR
U. S. DEPARTMENT OF TRANSPORTATION

AND
U. S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

## NOTICE



PREPARED BY
**DE LEUW, CATHER & COMPANY**

SUBCONTRACTOR TO
**GRUEN ASSOCIATES, INC.**

UNDER CONTRACT WITH THE
**METROPOLITAN TRANSPORTATION COMMISSION**

FOR THE
**U. S. DEPARTMENT OF TRANSPORTATION**

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This report is the final documentation of the BART Environment Project's study of the BART travel experience—the immediate effects of BART as an "environment" for its users. The BART trip is described as a process, following the user from the desire to take a trip to the completion of that trip and exit from the BART system. BART characteristics to be encountered at each stage of the trip are described and evaluated. Conclusions and implications for design of future transit systems are drawn.

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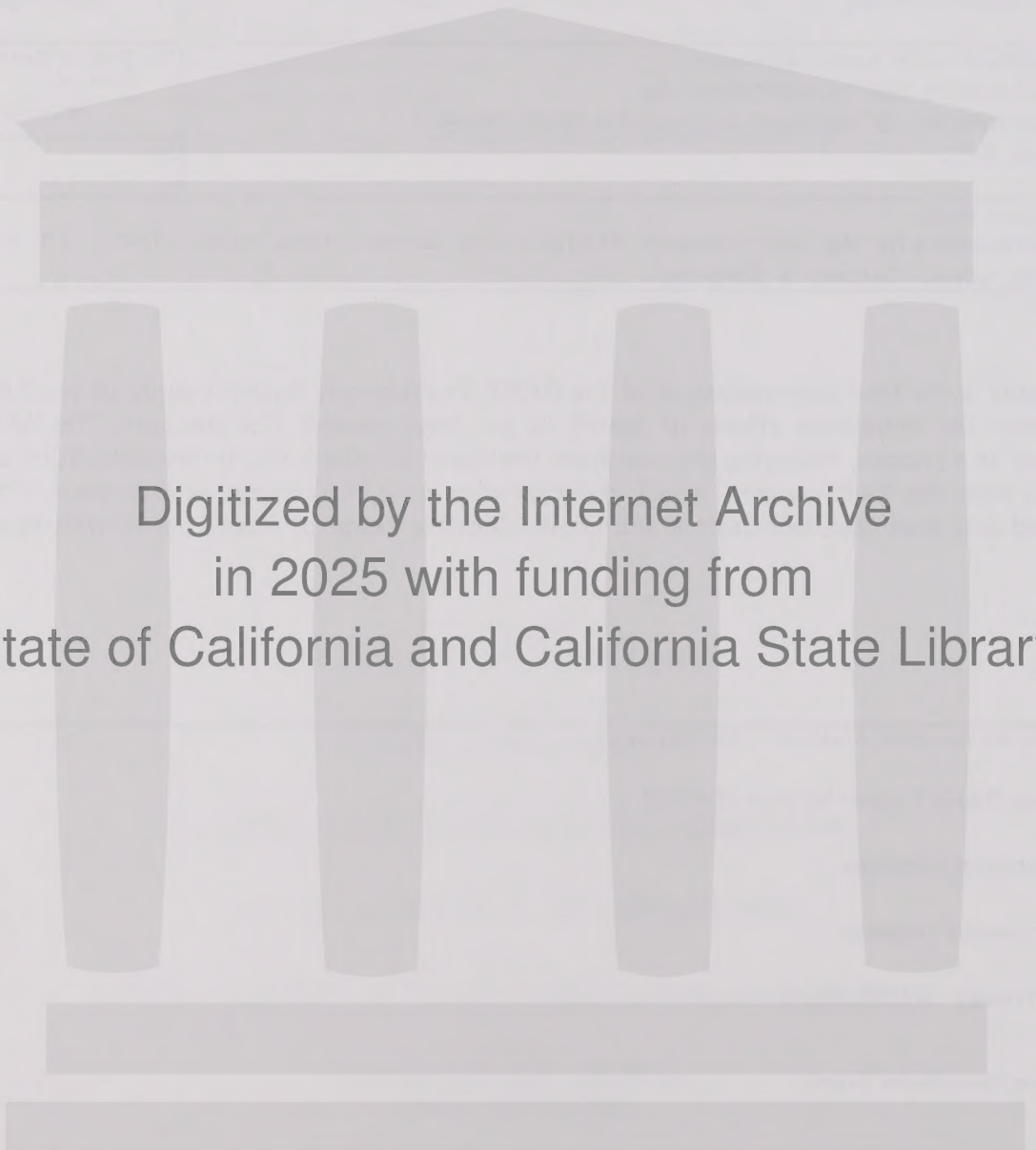

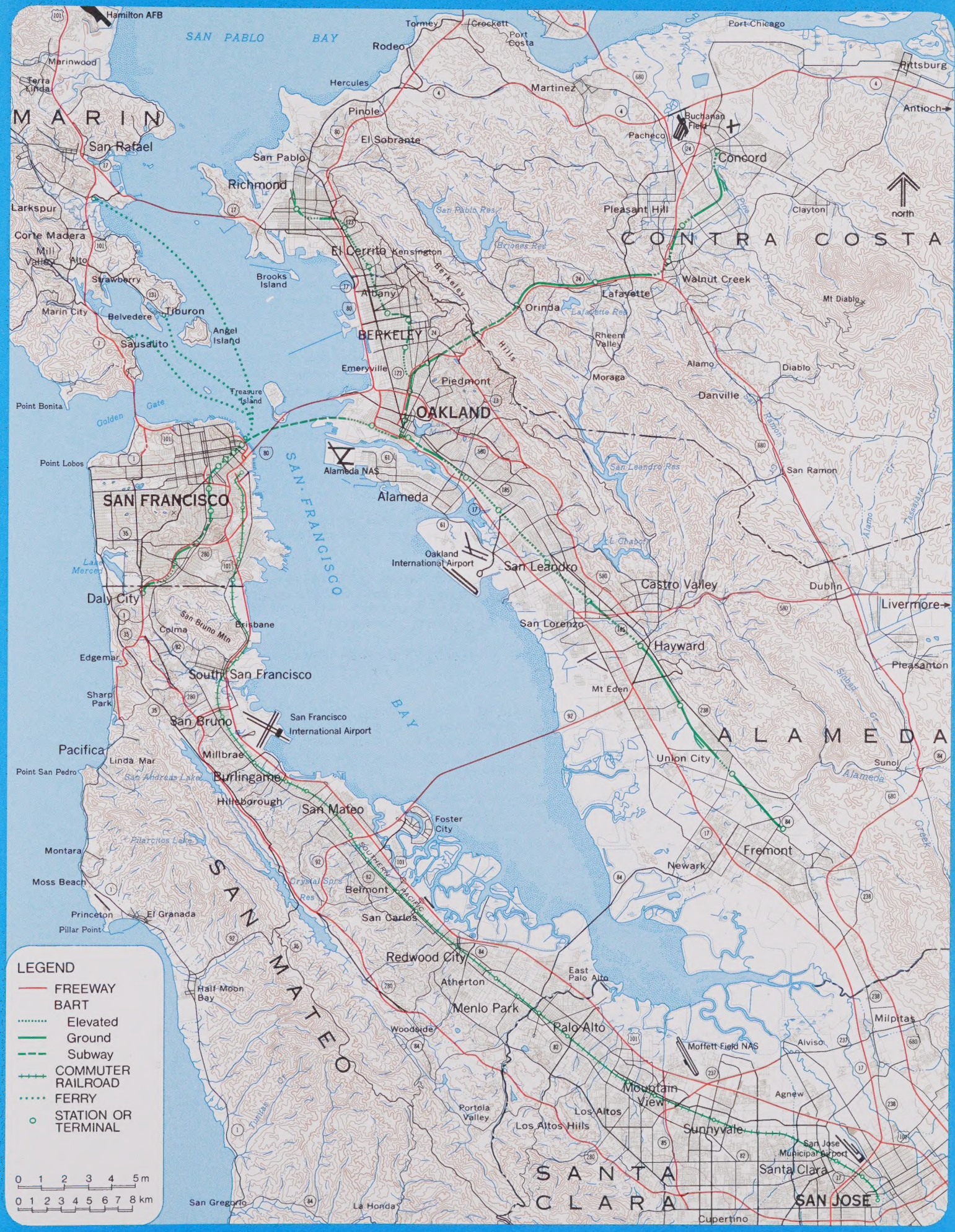


# SAN FRANCISCO BAY REGION

## CENTRAL AREA

Metropolitan Transportation Commission

# BART: THE BAY AREA RAPID TRANSIT SYSTEM

**Length:** The 71-mile system includes 20 miles of subway, 24 miles on elevated structures and 27 miles at ground level. The subway sections are in San Francisco, Berkeley, downtown Oakland, the Berkeley Hills Tunnel and the Transbay Tube.

**Stations:** The 34 stations include 13 elevated, 14 subway and 7 at ground level. They are spaced at an average distance of 2.1 miles: stations in the downtowns are less than ½-mile apart while those in suburban areas are 2 to 4 miles apart. Parking lots at 23 stations have a total of 19,000 spaces. There is a fee (25¢) at only one of the parking lots. BART and local agencies provide bus service to all stations.

**Trains:** Trains are from 4 to 10 cars long. Each car is 70 feet long and has 72 seats. Top speed is 80 mph with an average speed of 38 mph including station stops. All trains stop at all stations on the route.

**Automation:** Trains are automatically controlled by the central computer at BART headquarters. A train operator on-board each train can over-ride automatic controls in an emergency.

Magnetically encoded tickets with values up to $20 are issued by vending machines. Automated fare gates at each station compute the appropriate fare and deduct it from the ticket value. At least one agent is present at each station to assist patrons.

**Fares:** Fares range from 25¢ to $1.45, depending upon trip length. Discount fares are available for the physically handicapped, children 12 and under and persons 65 and over.

**Service:** BART serves the counties of Alameda, Contra Costa and San Francisco, which have a combined population of 2.4 million. The system was opened in five stages, from September, 1972, to September, 1974. The last section to open was the Transbay Tube linking Oakland and the East Bay with San Francisco and the West Bay.

Routes are identified by the terminal stations: Daly City in the West Bay, Richmond, Concord and Fremont in the East Bay. Trains operate every 12 minutes during the daytime on three routes: Concord - Daly City, Fremont - Daly City, Richmond - Fremont. This results in 6-minute train frequencies in San Francisco, downtown Oakland and the Fremont line where routes converge. In the evening, trains are dispatched every 20 minutes on only the Richmond - Fremont and Concord - Daly City routes. Service is provided weekdays only, between 6 A.M. and midnight. Future service will include a Richmond - Daly City route and weekend service. Trains will operate every 6 minutes on all routes during the peak periods of travel.

**Patronage:** Approximately 130,000 one-way trips are made each day. 200,000 trips are anticipated under full service conditions.

**Cost:** BART construction and equipment cost $1.6 billion, financed primarily from local funds: $942 million from bonds being repaid by the property and sales taxes in the three counties, $176 million from toll revenues of transbay bridges, $315 million from federal grants, and $186 million from interest earnings and other sources.

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This task of the BART Environment Project was designed and led by Robert L. Bishop of De Leuw, Cather & Company.

Other major contributors included the following:

| | |
|---|---|
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The study was under the supervision of Robert L. Knight of De Leuw Cather. Rebecca Brennan assisted as editorial consultant.

Special thanks are due the staff of the Bay Area Rapid Transit District, particularly Miriam Hawley and W. R. McCutchen who generously assisted in the documentation of BART's characteristics and in the review of some of the report's early draft materials.

## GUIDE TO USERS

The findings of this report are organized in two levels to accommodate the needs of different readers.

A concise summary of the study's major findings and conclusions is provided in the brief section beginning on page 1.

The complete findings are concentrated in the body of the report. It explores the various parts of the BART system sequentially, i.e., in much the same way a typical BART traveler would encounter them. Following Chapter One's general introduction and description of the approach, Chapter Two explains how a traveler locates and arrives at a BART station. Chapters Three through Six consider the traveler's experience in the station concourse, on the platform, aboard the train, and after the train trip. Chapters Seven and Eight reflect the experience of special users: handicapped patrons and bicyclists.

The final chapter (Chapter Nine) contains the study conclusions and implications for future transit systems planning, in the context of eight broad categories of BART's effects on travelers through the system.

The Index at the end of this document will facilitate the quick location of findings related to any specific factor considered in this study.

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## SUMMARY


### OBJECTIVES AND APPROACH

This study, a part of the BART Impact Program's Environment Project, is an assessment of the BART system from the traveler's point of view. It focuses on the BART trip as an experience, and progresses through each step in the travel sequence: finding and arriving at the BART station, entering and using the station facilities, waiting on the platform, riding on the BART train, and exiting from the BART system.

The study's objectives are to assess the performance of the system's major components as seen from the traveler's perspective and to identify those aspects which are particularly satisfactory or troublesome. To achieve these objectives a variety of assessment methods was used, including direct observation, instrument measurements, review of existing technical studies, and interview surveys of BART travelers and station attendants. These assessments suggest a wide range of lessons useful to transit policymakers, planners and designers elsewhere.

### TRAINS AND STATIONS

BART has 34 stations, 23 of which have parking lots. These are generally above-ground in suburban residential areas, while the remaining 11 are mainly downtown subway stations without parking. The stations vary widely in architecture, but are of high quality, visual interest, and are all functionally similar. In all cases the patron enters from the street or lot into the ticketing concourse, through the fare gates and up or down to the platform, onto the train, transfers at an intermediate station if necessary, and exits again through the fare collection system on the concourse level. The BART trains are from two to ten cars in length, with a maximum capacity of 700 seated passengers. They are modern in appearance and unusually high in passenger amenities.

### KEY CONCLUSIONS

- In most respects BART is a pleasure for the traveler to use, largely because of its high level of architectural quality, train interior design, and general amenity. In these respects, it may surpass most if not all other transit systems in the world.

- The system's lack of travel time reliability is a major weakness. The resulting inconvenience to patrons is compounded by the lack of information provided them regarding the likely causes and duration of such delays.

- Despite BART's simplicity of use for experienced riders, it seems very complex to many new or infrequent users. This results in an unexpected and excessive reliance on the station attendants for even basic information.

## MAJOR FINDINGS

### General Assessment

Within cost constraints, the highest possible levels of traveler protection and satisfaction are desirable goals in the design and operation of rapid transit facilities. BART was designed with these goals in mind, and the system is generally a pleasing and effective environment for patrons. Moreover, BART continues to improve its facilities and operations as deficiencies become evident.

When compared to virtually every other transit system in the world, the BART environment stands out in many respects. In particular, the visual interest of the stations and trains, the system's security and travel comfort are far superior to those of most other transit systems. BART is also relatively fast and inexpensive, particularly for end-of-the-line users. It is likely that these characteristics are major factors in attracting patrons. In addition, BART is fully accessible to handicapped persons and has facilities and programs to encourage bike access among patrons.

On the other hand, service and equipment reliability has been a problem. Equipment failures are more frequent than expected, although BART is working to improve the situation. Further, the limited station amenities and non-travel services (e.g., seating, restrooms) are sometimes inadequate due to train delays and a reduced frequency of normally scheduled service.

### Getting to BART

Gaining access to the BART system is relatively easy because many information aids were available to potential users. Experience in route to the station varies with the mode of access used. Information regarding access to BART is readily available by telephone, BART brochures, and most Bay Area maps. Most patrons arrive by auto, but BART parking lots are often full and there are some problems of internal traffic circulation. Bus service to BART typically carries patrons directly to the station door. There is feeder service to every BART station, although it varies widely in frequency and coverage. Many BART patrons approach the downtown subway stations on foot, and at some of the locations there are pleasant plazas which call attention to station entrances. With the exception of Market Street in San Francisco, signs at street intersections near most stations direct persons walking to BART. Also, the exterior architecture of the above-ground stations is quite easily identified by approaching patrons. Security is usually not a concern to patrons as they approach the stations. Crime rates in BART parking lots and plaza areas continue to be very low even though BART now operates into late evening.

### Inside the Station

Having arrived at the station, the patron enters and traverses the station concourse. Entrance into the station concourse is accomplished by any of four modes: level entry, elevators, escalators, and stairs. The concourse

areas are below ground in 11 stations, at ground level in 22, and elevated in one case. The concourse provides space for the entire ticketing/fare collection operation, a station agent's booth, directional and informational signs, and various passenger amenities.

The highlight of the traveler's experience at this point is the high visual quality of the station interior. The stations were designed by many different architects and with a minimum of BART-imposed constraints. As a result the concourse interiors vary widely in shapes and sizes of spaces, works of art, materials and colors.

Orientation and fare payment for first-time users may be confusing, although the system is simple to use after the first encounter. The major difficulties associated with fare collection are that the multiple step ticket-purchasing procedure is difficult to follow and the machines are subject to frequent jamming and breakdown. The functional layout of the concourse is similar in all stations, despite substantial architectural differences. However, signs to guide patrons are not always adequate. Concourse spaces are generally ample as are the patron ticketing systems. Non-travel amenities such as seats, concessions and restrooms are limited, since BART design was oriented to people spending very little time in station areas. Accidents in station concourses are rare, and those that occur are apparently not due to design faults. Most are falls, usually happening on ramps, steps, stairs and escalators. Emergency help in stations is provided first by station agents. Further help is available via an easily accessible intercom with a response time of about four or five minutes for the arrival of BART police or local patrolmen.

On the Platform

Passengers board BART trains directly from the station platform, which is accessible from the concourse by stairways, escalators and elevators in all stations. Fourteen of BART's stations have subway platforms below the concourse. In the remaining 20 stations, the platforms are above an at-grade or elevated concourse. There are both center- and side-loading platforms.

Platforms are visually interesting, generally comfortable, safe and secure environments. However, the lack of information about train delays, which are frequent, is a major source of complaint among patrons. BART is currently taking steps to improve the quality of such information for patrons on platforms as well as on trains. Seating and other amenities such as telephones are in short supply as well. Weather protection is provided by partial roofs and recently installed glassed-in shelters on the above-ground platforms. To a person familiar with platform noise as a train arrives in older subway systems, BART is phenomenally quiet. Patron survey results and measured noise levels confirm this result. Localized air pollution levels even on freeway median platforms are not a problem.

On the Train

The BART car is one of the most luxuriously appointed rail commuter vehicles in the world. It was designed to attract commuters from their autos by offering a very high level of comfort while still making the interior durable,

simple and easy to maintain. Survey results indicate that persons who ride BART are pleased with its comfort. In addition, BART's travel time ratings are good, in spite of delays caused by low equipment reliability.

BART cars are clean and well-maintained. Seats and ride quality are excellent. There is generally a low level of vibration with little sway. The air conditioning system and interior lighting also contribute to ride comfort. Interior sound levels somewhat exceed criteria set by the Institute for Rapid Transit, but seem low and cause no significant discomfort or complaint. Ear discomfort is often experienced as trains enter the Transbay Tube. This discomfort is probably due to the sudden air pressure changes which occur as the train passes the tube's vent shafts. Occasional rapid acceleration to 70 mph from a stopped position also makes some persons uncomfortable. Neither of these is serious, but similar effect could probably be reduced in future systems. Windows are large and the view is excellent.

Train seating is readily available except during rush periods. The cantilivered seats make maintenance of the carpeted floors easy, and also provide ample package space beneath. Each car seats 72 patrons, but during peak periods, twice that number may ride standing up. Not all rush hour standees can reach a handrail. However, accidents are rare and occur mainly on boarding and exit. Crime is also very uncommon, and there is little nuisance from drunk or rowdy patrons. Emergency aid can be reached via the same kind of intercom system used in the stations, and has the same problems of unreliability and sometimes show response. System display maps on trains and station arrival announcements by train operators make getting off the train at the appropriate station usually not a problem.

BART trains run on computer-controlled headways (intervals between trains) rather than on time schedules. Service is often unreliable, however, and train delay is one of the major complaints patrons have about the system. In early 1977, about 10 per cent of all train headways exceeded their targets (6 or 12 minutes, depending on which line is considered) by more than 50 per cent. In a recent review of transit patron attitude studies, it was concluded that travel time reliability is even more important to patrons than the total elapsed travel time.[1] This study's limited interviews with BART patrons also found reliability to be a major concern. BART's biggest problem since the inception of service has been low equipment reliability, which affects both the level and quality of service. Problems occur primarily among transit vehicles, in which high rates of component failure cause reductions in speed, thereby slowing system operations.

## Leaving the System

A traveler's main concern after the BART train trip is exiting from the station as quickly as possible. This involves passing through the fare gates, finding the correct station exit and, in some cases, connecting with another transit mode.

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[1]M. Wachs, "Consumer Attitudes Towards Transit Service: An Interpretative Review," AIP Journal 42, January 1976, p. 103.

Two sets of double doors on each side of the car accommodate relatively quick movement out of the vehicle. Train doors usually remain open for 15-30 seconds, depending on the degree of crowding.

While exit signs on platforms indicate locations of escalators and stairs, they do not always specify where exits lead in relation to surrounding streets. Elevator locations are not marked. Infrequent users tend to become confused by the procedure at the fare gates, thereby delaying others. In such cases, lines may form at the "Addfare" and change machines near fare gates, causing traffic congestion.

Finding a connecting bus can be difficult for infrequent BART users due to the lack of effective signing in some stations and at nearby bus stops; a more effective signing system is being planned for installation.

## BART and the Handicapped

BART is accessible to handicapped persons, including those in wheelchairs. However, handicapped patrons encounter special problems associated with accessibility, orientation and barriers to movement within the system itself. Most problems occur because provisions for handicapped patrons (most notably elevators) were added late in the design process. Currently, a task force of handicapped persons advises BART about desired improvements to facilities and allocation of resources to that end.

To ease the handicapped person's task of gaining entry to a BART station, many layout modifications have been made, such as special auto stalls in parking lots and gradual ramps over curbs and obstacles. Entrance gates, fare-vending equipment, telephones, restrooms and other station facilities have been designed with the problems of the mobility handicapped patron in mind. For the blind patron, however, orientation is problematic and movement is often hazardous due to a lack of non-visual guides in BART stations. Stair entrances and platform edges often have no textural differentiation. Patrons who must rely on elevators have found getting to the train time-consuming, complicated and exhausting. They are subjected to long travel distances, unreliable intercom phones, and complicated fare-collection procedures. These inconveniences should be eliminated in future systems which provide for mobility-limited patrons in the original designs.

Handicapped patrons have additional difficulty in boarding trains and frequently need individual assistance and additional accessories for balance and support. There are no provisions for wheelchairs on the trains. The blind or near blind must often rely on other riders for assistance in boarding and detraining. However, accidents have been rare.

## BART and Bicycles

In response to the trend toward use of bicycles for transportation, BART has provided bike storage facilities at all stations except those in downtown areas. A program allowing patrons to transport bikes on BART with some restrictions has also been implemented.

Theft preventive bike racks are provided at all suburban stations. At present, about 650 bike lockers are being installed for further theft protection.

The Bikes-on-BART program allows standard bikes on BART by permit during non-rush hours in certain locations on trains. Currently over 2,000 persons have bike permits and about 200 cyclists a week take advantage of the program. Folding bicycles are allowed in the system without permit or restriction.

# CHAPTER ONE

## INTRODUCTION AND APPROACH

### STUDY BACKGROUND AND OBJECTIVES

The San Francisco Bay Area Rapid Transit System (BART) is the first major rail system built in the United States in more than half a century. The BART system is of great interest to federal, state, and metropolitan governments as they consider proposed major transit improvements in areas across the country. The BART experience provides many lessons of value in such decisions on investment and planning, not only in other areas but for BART itself.

BART's development has been well publicized and highly controversial. Its construction was slow, its final costs exceeded initial predictions, and the system's management has been and continues to be faced with a series of major problems in keeping BART running both mechanically and financially. However, major efforts are being made to remedy the system's operational problems and the situation is constantly improving.

Within the context of the BART Impact Program, this study is concerned with the quality of the traveler's experience in trains and stations. The purpose of the study is to identify and assess those factors in the BART train and station environment which potentially affect the traveler's experience. Qualities inherent in the design and operation of the system may strongly influence an individual's decision to make a trip by BART. Even when individuals have no choice but to use BART, certain aspects of the system influence the quality of their experience. When these factors are perceived as positive or "pleasant" in nature, they can be considered as inducements to travel. When they are negative, disturbing, create confusion or actually endanger people, they are likely to be deterrents to use. Basically, then, the questions that needed to be considered in this study are:

- What particular factors potentially affect users of the BART system? Are these effects positive or negative?
- Where are these factors present to any significant degree? System-wide or only in specific locations?
- How are users affected by the factors, and in general, how do they perceive them?
- What can or should be done about the effects?
- What are the design and policy implications -- the lessons learned from BART for future transit system planning?

Both qualitative and quantitative techniques of assessment were used, since no one method of approach was suitable for assessment of all the diverse factors. The scope of the study was constrained in some cases by time and budget. For example, certain possibly useful quantitative measurements could not be taken. Similarly, user interviews were only possible with a small sample, and the results could only be summarized qualitatively with no attempt at statistical analysis. However, the study is comprehensive and no major issues were knowingly avoided because of any such constraints.

## THE BART DESIGN PROCESS

### Organization

Design responsibility for the BART stations was shared by two groups of architects: those who guided and coordinated the overall program, and the individual station architects.[1] An early and continuing participant in the first group was the Consulting Architect and his advisors. They were responsible to the three-firm joint venture general engineering consultants to BART, Parsons Brinckerhoff-Tudor-Bechtel (PBTB). Donn Emmons served as the first Consulting Architect on a part-time basis from 1963 through 1966. During that time the Architectural Manual was developed; the decision to use different architects for different stations was made, and the architects selected; early conceptual station designs (for station budgeting) were formulated; and BART's aerial trackway structures were designed. Tallie Maule replaced Emmons as Consulting Architect and subsequently became the joint venture's permanent Chief Architect. It was his responsibility to coordinate and work with the architectural firms selected to design BART stations. He did so for nearly the entire remaining design and construction period.

Under the administrative control of a central office, each of PBTB's three participating firms took responsibility for completing one sector of the system. Each firm in turn hired individual project architects (generally on the recommendation of the Consulting Architect) for facilities on its sector. A total of 15 architectural firms and 8 landscape architectural firms designed the BART facilities, along with several graphic designers, industrial designers and artists.[2]

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[1]Comprehensive discussion of the architect's role in the BART design process can be found in: Robert Betts, "Design of Bay Area Rapid Transit Station," (Master's thesis), University of California, Berkeley, 1973.

[2]Appendix Table C.1 lists the architect and landscape architects for each BART station and Table C.2 enumerates individual station characteristics and facilities.

## Design Objectives and Criteria

General criteria for station design were set forth in BART's Manual of Architectural Standards (hereafter referred to as the Manual).[1] Each station was to be detailed to fit its specific site, purpose and flow of patrons. The Manual's Foreword established the architect's role as that of developing a station which "meets standards and requirements established for all stations, and at the same time is a separate unit, with its own individuality and architectural character." Within the limits set by systemwide engineering criteria, the station designers were encouraged to seek solutions which would be innovative and attractive. The criteria in the Manual stress the importance of providing for the patron's comfort and convenience by urging architects to design stations which are inviting, well-lighted, clean and, especially important, stations in which the passengers can move about with a minimum of crowding and a maximum of convenience.

The Architectural Manual was a general architectural program for the stations. Accordingly, it contained only enough information on technical design aspects (such as platform dimensions, mechanical and electrical systems, communication systems, train control systems, and heating/ventilating systems) to enable architects to make necessary space allocations. Some of the requirements, however (such as the 700-foot-long train platform; the 280-foot canopy covering the above-ground platform; and the program for placement of ticketing machines, fare gates, station agent booths and vertical circulation elements), gave strong elements of consistency to the resulting form and design of all stations.

A similar manual was also developed for engineering design criteria.[2] In addition to the architectural and engineering manuals, the architects were guided by several more specific plans developed by BART for each station:

- Plan of External Traffic -- provided data on station access for development of traffic flow patterns around stations, including handling of pedestrians, buses and kiss-and-ride patrons.
- Site Development Plan -- established location and boundaries of station sites, as well as parking layout and landscaped areas.
- Station Definitive Plan -- established location of the platform and station core (the portion of the station containing the fare collection equipment, station agent's booth, concessions, toilets, waiting areas and service areas).

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[1] SFBARTD Manual of Architectural Standards Z301, Parsons-Brinckerhoff-Tudor-Bechtel, San Francisco, June 1965.

[2] Parsons-Brinckerhoff-Tudor-Bechtel, Civil and Structural Design Criteria, Volumes I and II, San Francisco, 1968.

## MAJOR USER-RELATED FEATURES OF BART

### General System Layout

The four BART lines are roughly in the form of an "X" with arms extending generally from the downtown Oakland-San Francisco core outward to four different suburban areas (see Figure 1.1). Two of these terminals (Fremont and Concord) are in newer and now-developing residential areas, each over twenty miles from the CBD. The other two (Daly City and Richmond) are in older and fully built-up residential-commercial areas less distant from the center.

In all four of its suburban arms, the BART lines and stations are primarily on aerial trackway or at-grade (51 miles), while most of its central portion is in subway (13 miles). Adding to this the seven miles of the Transbay Tube and the Berkeley Hills Tunnel, the system's total length is 71 miles of double track.

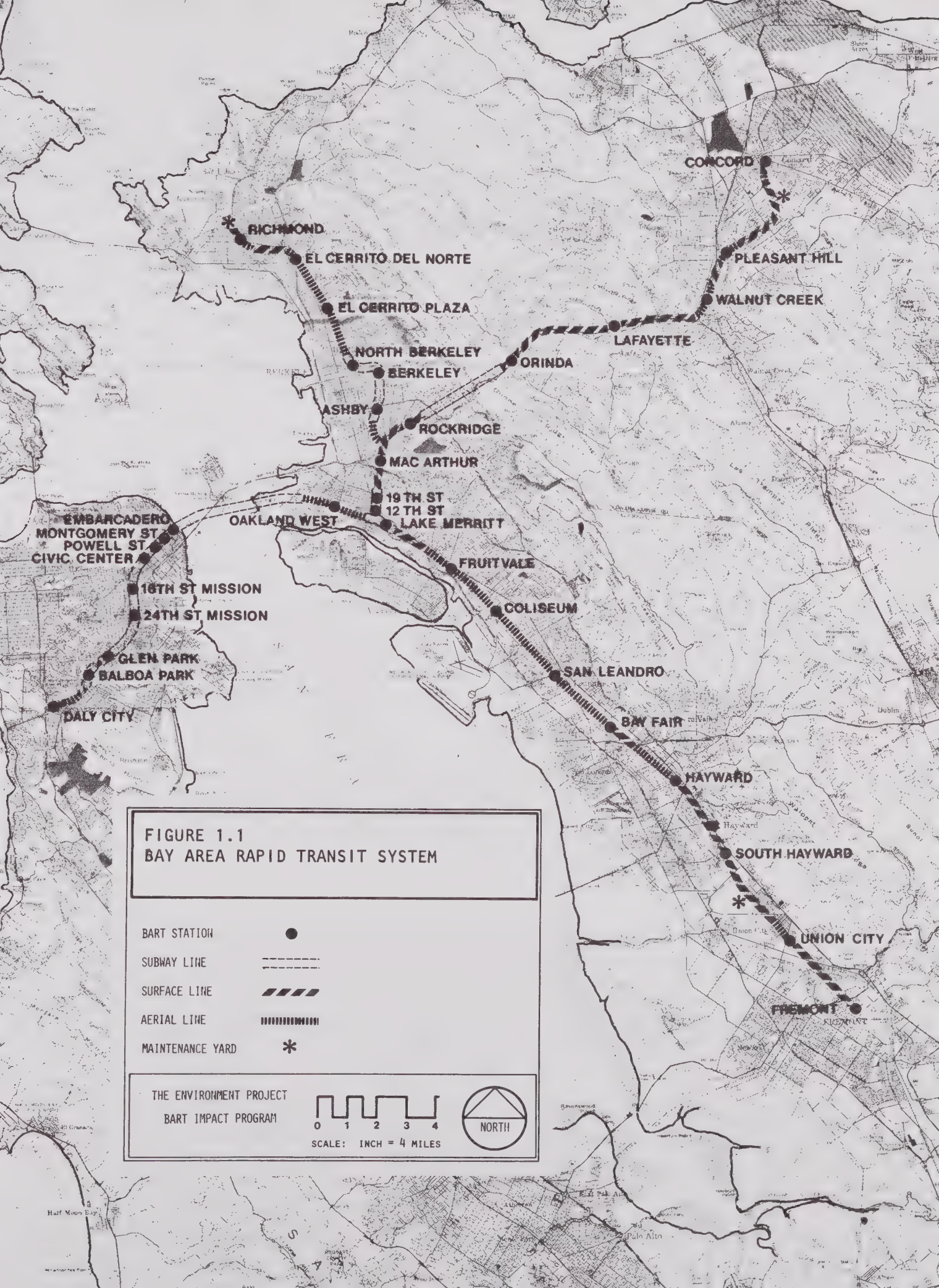
### Station Types

BART's stations fall into two general groups convenient for description of user-related characteristics. There are thirteen stations which are downtown or "destination" (work, shopping) stations, mostly subway, near the center of the system. The remaining 21 are "origin" stations (residential); most are elevated.

The origin stations generally have parking lots, relatively light bus feeder service, and large above-ground station structures. Most patrons drive or are driven to these stations. In contrast, the destination stations include almost none with parking, all have extensive bus service, and the stations are generally below ground with little visible evidence of their presence.

### Station Components

All BART stations have three main components: an approach, a concourse, and a platform. The BART traveler passes through each of these in turn on the way to a BART train, and exits in the same way. The approach includes the (suburban) parking lots, (downtown) entry plazas and the station entrance itself. The concourses are enclosed, and house functions such as ticket sales and collection, information, and various concessions and other services. These are below ground in most subway stations and at ground level for most elevated stations. The platforms include both center (between the two tracks) and side types (outside the tracks). In elevated stations, they are directly above the concourse; for subway stations, just below.


CONCORD
PLEASANT HILL
WALNUT CREEK
LAFAYETTE
ORINDA
RICHMOND
EL CERRITO DEL NORTE
EL CERRITO PLAZA
NORTH BERKELEY
BERKELEY
ASHBY
ROCKRIDGE
MAC ARTHUR
19 TH ST
12 TH ST
OAKLAND WEST
LAKE MERRITT
EMBARCADERO
MONTGOMERY ST
POWELL ST
CIVIC CENTER
16TH ST MISSION
24TH ST MISSION
GLEN PARK
BALBOA PARK
DALY CITY
FRUITVALE
COLISEUM
SAN LEANDRO
BAY FAIR
HAYWARD
SOUTH HAYWARD
UNION CITY
FREMONT
FIGURE 1.1
BAY AREA RAPID TRANSIT SYSTEM
BART STATION
SUBWAY LINE
SURFACE LINE
AERIAL LINE
MAINTENANCE YARD
THE ENVIRONMENT PROJECT
BART IMPACT PROGRAM
0 1 2 3 4
SCALE: INCH = 4 MILES
NORTH

## RESEARCH APPROACH

After an extensive review of related research literature[1] and discussions with professionals experienced with BART or engaged in similar research, eight general categories of basic importance to transit system users were selected:

- Orientation (of traveler to the use of the system).
- Reliability (of equipment and service).
- Convenience (in using the system to reach desired destinations quickly).
- Safety (from accidents and/or fear of accidents to self and/or property).
- Security (from crimes and/or fear of crimes to self and/or property.
- Comfort (seating availability and other basic physiological needs).
- Enjoyment (aesthetics, cleanliness, maintenance, and travel interest).
- Non-Travel Services (amenities provided in the train and station).

The main use of these categories was as a convenient means to identify and group the many specific factors in the BART environment which are of interest to the traveler. No attempt was made to define the categories psychometrically in terms of the factors or to correlate them in any way statistically.

Figure 1.2 gives an example of the relationships between a general category, a factor within a category, the desired measure, and the methods used for study. Comfort as the category and sound as the factor are used for illustration. Each factor studied was considered in this way.

## STUDY METHODS

In order to study the diverse set of factors identified in the BART environment, six methods were utilized. Much of the subject matter was "soft." That is to say that physical measurements could not be taken, and data were not available that could be analyzed statistically and compared with established standards. Given the qualitative nature of many factors, the factors were evaluated using several methods and judgments to develop more valid conclusions.

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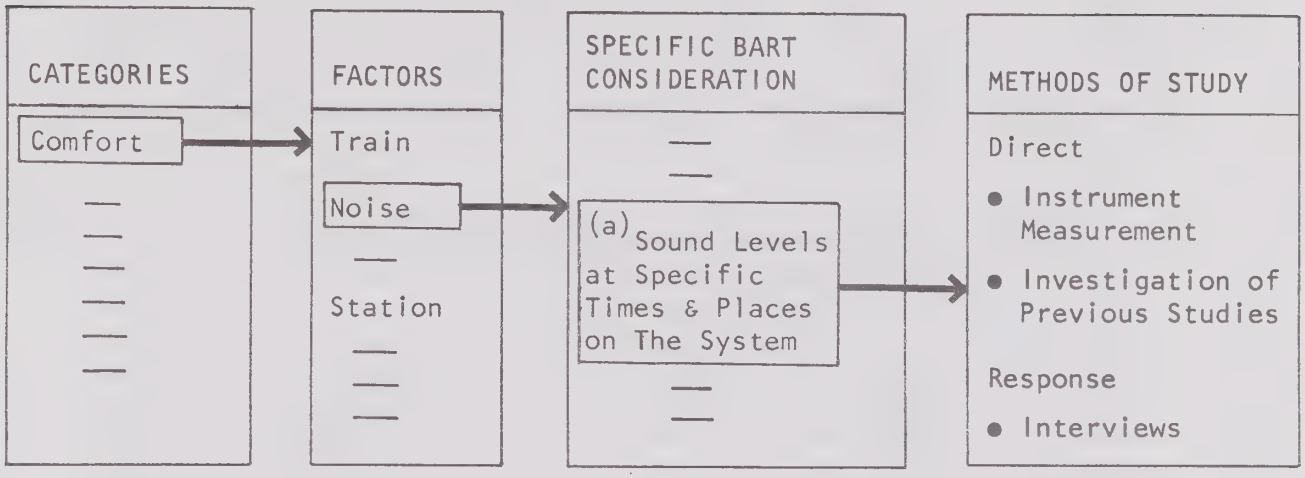
[1]See References for a complete list of the literature reviewed during this study.

Figure 1.2
RELATIONSHIPS AMONG CATEGORIES, FACTORS, AND METHODS OF STUDY




With regard to stations, initial attempts were made at selecting a core set of sites for study of most factors. Stations were chosen to represent a wide range of types, purposes and surrounding environments as well as a diverse sampling of the work of architects who designed BART stations. However, the BART system's 34 stations are extremely diverse in design and characteristics of use. It was eventually concluded that no single subset of stations could be chosen to accurately represent the system-wide variation of all factors in the study. Consequently, factors were considered on a systemwide basis or at different sites depending upon specific needs. The main criterion for selection of sites to be inspected was an indication that best, worst, or "typical-of-the-system" conditions were present there with respect to an individual factor or set of specific factors. Such a site selection process involved developing and making use of detailed knowledge of all the stations rather than only a few.

Evaluation of the trains involved no site selection. The trains themselves are uniform throughout the system, and external factors such as ride quality, sound, and view were evaluated using systemwide observations and data. The major methods of study were as follows:

- Direct Observation and Professional Evaluation of the System: Since much of the data needed was qualitative in nature, this particular form of examination was relied upon heavily during the study.

- Investigations of Records, Documents, and Historical Data: Accident and crime rates, complaint files, reliability and maintenance data, etc., were considered as well as initial design criteria and the role of policy changes which determined the present aesthetics and functional design.

- Interviews with BART Personnel and Other Authorities: Key informant interviews were found to be an excellent and comprehensive source of information and were used whenever applicable.

- Review of BART Environment Project (ENV) Phase I Findings: Data already gathered in the first phase of the ENV project had relevance to this particular substudy. However, due to changes and present uses of the system, updating of the data was necessary.

- Measurement Using Instrumentation: Ambient measurements of acoustic, vibrational, and atmosphere conditions seemed necessary both on trains and in stations. However, with regard to vibration and temperature measurements, much of the necessary data had already been gathered in other studies. With regard to sound, other data sources were useful, but the primary source was a series of sound level recordings made in nine representative BART stations and on board seven different BART cars during two complete end-to-end traverses of the system (see Appendix B). Air quality was evaluated only with respect to potential violation of accepted standards since detailed instrument measurements necessary for more specific data were beyond the scope of the study.

- Patron and Station Agent Questionnaire: In-depth interviews were given to a sample of some sixty BART riders and fifteen station agents throughout the system. The purpose of the survey was to give the researchers further indication of whether factors being evaluated were considered positive or negative or even noticed at all by users. The sample was selected to include a reasonable cross section of views, but was not intended to provide a basis for statistical tests. Commuters, off-peak riders, new users, and handicapped patrons were included.

  The survey instrument was constructed to ascertain the dominant impressions gained by BART users from riding on the system. Interviewees were asked to consider a typical BART trip and to mention those things they noticed most in specific areas along the way. After surveying the riders, the questionnaire was administered to BART station agents to get their point of view from experience in operating the stations. The survey instrument and procedures were pretested on a sample of BART riders and then modified for subsequent use.

  Participants were obtained by contacting patrons briefly on the system and later interviewing them in depth by telephone. Handicapped users who participated were drawn from those contacted in a previous MTC survey of some 1,200 persons who had obtained discount cards for transit use in the Bay Area. Station agents were interviewed at 12 different stations.[1] The characteristics of patrons interviewed and a sample questionnaire are included as Appendix D.

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[1]Richmond, Berkeley, Concord, Lafayette, MacArthur, 12th Street-Oakland, Hayward, Coliseum, 24th and Mission, Civic Center, Powell Street and Embarcadero.

# CHAPTER TWO

## GETTING TO BART

### GENERAL CHARACTERISTICS

This chapter deals with the portion of a BART trip prior to the time a patron enters the BART station, including how to find BART, how to select an access mode, and the specific experience of the auto driver/rider, bus patron and pedestrian, as they approach the station entrance.

Potential BART users are likely to consult printed materials (maps, brochures) or telephone the BART information number to resolve questions about access to the BART system. The experience of getting to the BART station varies widely with each mode of access. The auto user follows street signing, locates the station, encounters the parking lot or drop-off location, and becomes a pedestrian the last few hundred feet to the station entrance. The bus rider locates the appropriate bus stop and bus identification, rides to the station, and walks a few feet to the station entrance. The pedestrian looks for signs to the station entrance, seeking the greatest safety and the most direct route.

Virtually all BART parking lots and stations are adjacent to major arterial streets or freeways. Because of the 700-foot-long elevated platforms and the large enclosed concourse beneath, the above-ground stations are large and visible (Photo 2.1). Most of the subway stations are inconspicuous, although typically the surrounding streetscape has been renovated and small public plazas have been created around several entrances (Photo 2.2).

Mode of arrival at BART depends on the character of the surrounding community. Seventy to eighty percent of BART patrons from low-density suburban areas use auto park-and-ride and auto kiss-and-ride (drop-off) feeder modes. In these areas, BART parking lots encourage this use of the automobile to get to the station. Twenty-three of BART's 34 stations have parking lots, ranging in size from about 225 to over 1,400-car capacity. At one station (Daly City), a large parking garage is being built to increase parking capacity.

Low population density and high auto ownership in the suburban areas result in limited suburban feeder bus service. Persons who are planning to use suburban feeder bus service will find it generally oriented to the rush-hour commuter. Persons traveling at night will find bus service very limited, and three stations (Daly City, Bay Fair, and South Hayward) have no night service at all.

In high-density areas, 80% of the patrons walk or use feeder buses to connect with the BART system. Only 20% of the patrons come by automobile. Factors influencing mode choice are good transit service, the high cost of auto insurance, and the difficulty of parking near BART stations.

PHOTO 2.1

ABOVE GROUND
BART STATION
(SAN LEANDRO)

PHOTO 2.2

BART STATION
PLAZA
(MONTGOMERY)

## INFORMATION AIDS

### How does one locate BART?

"All About BART" is a blue, black, and white foldout brochure indicating travel time and fares between stations on the BART system. Instructions regarding the ticketing process, entry gates, and "Addfare" machines are included. Reference is made to hours of service, special fare discount tickets (youth, handicapped, and senior citizens), feeder bus fare discounts, BART's telephone information number and other items. "All About BART" is available at the BART stations and distributed in tourist information packets and at presentations by BART staff.

"BART and Buses" is an attractive multi-color brochure, graphically coordinated with BART logo, station mapping, and vehicle and station signing. Most users find it helpful in locating feeder bus routes, bus schedules and fare pricing. This brochure also explains how to use the BART system.

Both "All About BART" and "BART and Buses" have been periodically updated to reflect revisions in BART and feeder bus scheduling. General distribution and public reaction to these printed materials has been good, and they are now being published in English, Spanish and Chinese.

The BART telephone center provides toll-free schedule and fare information for BART and connecting bus service. Operators speak English, Spanish, and Chinese. Information lines are not overloaded, and the public has been appreciative of the prompt and courteous operator response.

Other informational aids include street maps (AAA, Rand McNally, gas station), local transit schedules (AC[1] and Golden Gate schedules available on buses; MUNI[2] schedules available at administrative headquarters), telephone book transit route and schedule displays, tourist guidebooks, hotel and department store displays. Station attendants, bus drivers and the passing public are also indispensable sources of information and assistance.

Attitudinal surveys identified no inadequacies with the content, design or distribution of the information aids.

## AUTO ACCESS TO BART

### What directional signs are there?

Blue freeway exit signs direct auto travelers to the nearest BART station. However, the signs do not identify the station name, and once one reaches the arterial street, there are few additional signs leading to the station. BART passengers surveyed believed signing of routes to the station was more effective in the East Bay than in San Francisco.

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[1]AC refers to Alameda-Contra Costa County Transit District ("AC Transit") which serves the East Bay (all of BART's service area except San Francisco-Daly City, which is termed the West Bay) and provides transbay service.

[2]MUNI is the San Francisco Municipal Railway, which operates the bus-streetcar-cable car system in the city.

When approaching many of the stations during the peak period, the auto user may experience traffic congestion, while at other times of the day traffic may flow smoothly. However, most of the BART patrons surveyed rate accessibility favorably.

Are the stations easy to recognize?

The ability of patrons to more easily locate East Bay stations than San Francisco stations may derive, in part, from the greater proportion of above-ground stations in the East Bay and relatively high proportion of subway stations in San Francisco. The above-ground stations with building mass, distinctive architecture, guideway prominence, and the large parking lot surrounding the station make it easier for the approaching auto driver or passenger to identify the station location.

Subway stations (the predominant type of station in San Francisco, central Oakland and Berkeley) offer the approaching driver few visual clues as to location -- usually a single 3-foot wall surrounding the subway portal with station name displayed in small lettering. Street beautification, in the vicinity of BART subway stations along Market and Mission Streets in San Francisco, Broadway in Oakland and Shattuck Avenue in Berkeley can indicate to the experienced BART rider that he is in the general vicinity of a station. Open plazas associated with the Mission Street, Civic Center, and Powell Street Stations make these stations the easiest subway stations for the auto user to locate.

Are entrances to parking lots easy to negotiate?

Since there are no signs at stations indicating the preferred park-and-ride entrances, most first-time users enter stations at entrances closest to approaching streets. However, this was not intended, according to the Manual (Section 14.4): "As they near the parking lot, all private cars will be directed by signing to appropriate entrances, while bus, taxi and vendor traffic will proceed to their own special areas, which will be signed to prohibit use by private cars."

In many cases, patrons encounter lots with confusing circulation systems. Exceptions to this are the rectangular lots at the North Berkeley, Lake Merritt, Oakland West and South Hayward stations, where the simplicity of the site shape and street layout have facilitated the design of effective parking lot circulation plans. Particular problems are evident at Pleasant Hill, Bay Fair and Daly City. At Pleasant Hill Station (Photo 2.3) for example, the following problems were observed:

- Lot entrances are in a poor location, i.e., on a side street away from traffic or too close to a major intersection.

- Signing does not direct the driver, i.e., uncertainty whether entrance or exit, kiss-and-ride; or park-and-ride.
- Internal circulation is circuitous, i.e., structural intrusions require navigation through a maze.
- Some key roadways are one-way when they should be two-way. This results in many wrong way movements.
- A driveway at the rear of the lot is too narrow, i.e., it constricts traffic flow and is hazardous.
- Many traffic control signs are nonstandard and poorly placed, thereby confusing auto drivers.

PHOTO 2.3
PARKING LOT CONGESTION
(PLEASANT HILL)

The Bay Fair station area contains a unique, curved underpass between two parking lots, where blocked view of oncoming traffic has contributed to several accidents. Circulation at the Daly City station lot requires a $90^{o}$ turn into a narrow driveway immediately after entering the lot from the street. In each case, drivers are required to negotiate unexpected or atypical movements without adequate signing.

Despite the often confusing parking lot circulation systems, vehicle accidents within the parking lots do not appear to be a particular problem.

Police records for the February - April, 1976 period (Table 2.1) indicate few accidents and that collisions between two moving vehicles are the most common accidents. Accident rates appear consistent with experience in other large parking lots, e.g., those at shopping centers and major workplaces.

BART officials believe that few accidents are reported. Most unreported accidents are "fender benders" which occur when drivers back out of parking spaces. BART officials believe that low speeds in the lots (15 MPH) contribute to keeping accident figures low.

TABLE 2.1
VEHICLE-RELATED ACCIDENT REPORTS, BART PARKING LOTS[1]
(February-April 1976)

| Type of Accident | Number of Reports |
|---|---|
| Motor Vehicle vs. Motor Vehicle | 8 |
| Motor Vehicle vs. Pedestrian | 1 |
| Motor Vehicle vs. Fixed Object | 3 |
| Parked Vehicle vs. Other Vehicle | 3 |
| | 15 |

[1]Accidents reported to BART police only.

Is it difficult to find a parking place?

Currently there are approximately 19,601 parking spaces available in lots at 23 stations on the BART system. 1577 of these spaces are for mid-day parking and commuter drop off/ pick up only. Lot sizes range in size from 197 at Lake Merritt Station to 1,483 at Pleasant Hill Station. Large lots are generally at above-ground stations located in suburban areas. No parking is provided at San Francisco, downtown Oakland and downtown Berkeley stations.

Persons planning to park and ride in the morning rush (7:00 - 9:00 AM) have about a 33% chance of entering a lot which is already full. Figure 2.1 shows the average maximum parking lot use for weekdays in May, 1977. One lot with excess parking demand (Daly City) is soon to have expanded facilities. Five other lots have already been expanded, (Hayward, Union City, Fremont Lafayette, South Hayward). Two of these lots still have capacity problems, (Lafayette, Fremont).

Patrons entering the lots at midday are provided with special parking spaces, usually to the side of station entrances. However, there is no signing directing users to these spaces from the street, and the

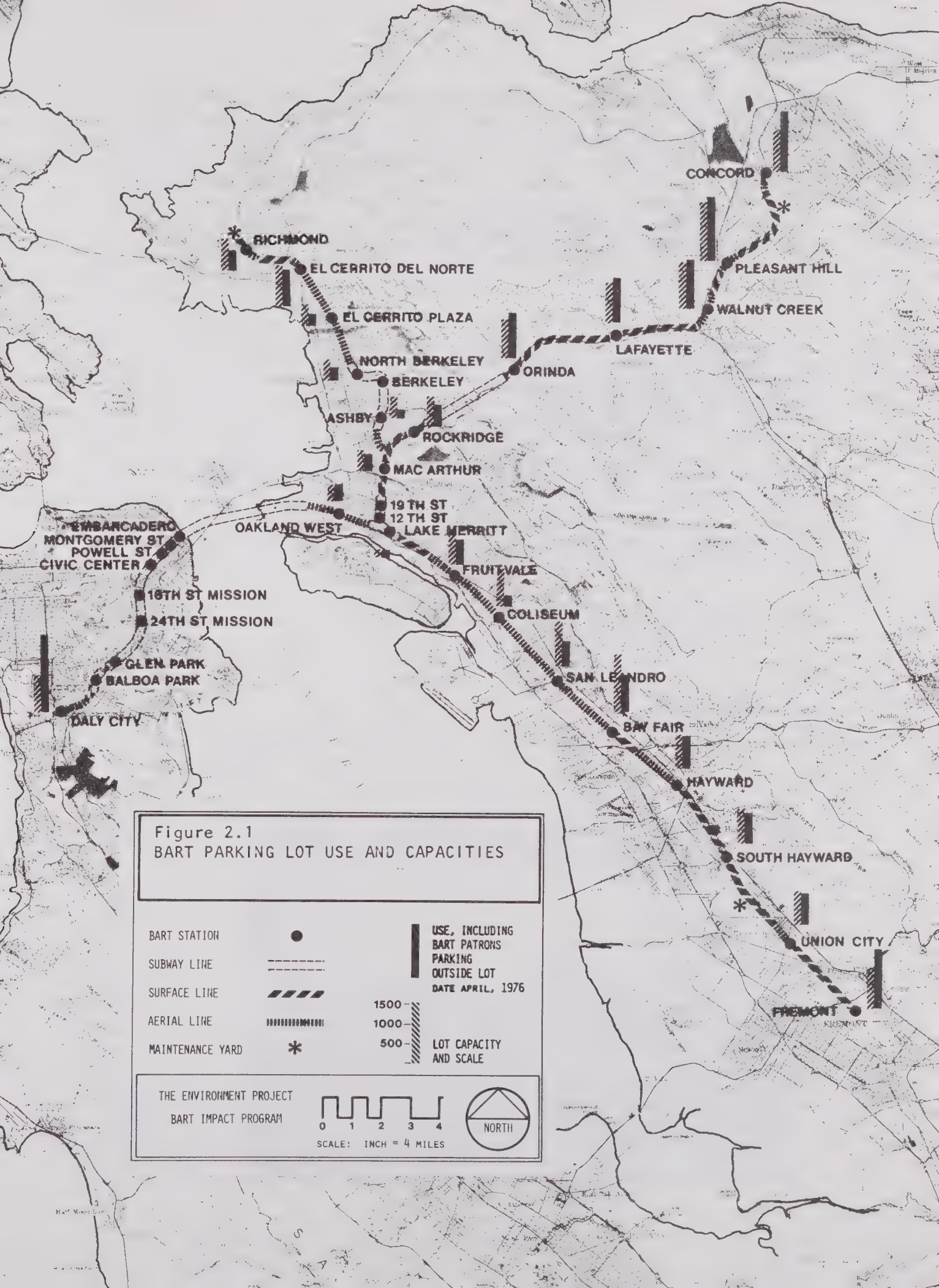


Figure 2.1
BART PARKING LOT USE AND CAPACITIES

signing within the lot is often confusing and inconsistent. Three different types of signs identify these special spaces. The sign saying "RESTRICTED PARKING" seems to discourage drivers from using the spaces. Sometimes commuters park in the midday spaces. Time limits are only occasionally enforced. It was originally assumed by BART that control could be provided to keep the spaces free of commuters. One BART official believes that many stations have too many designated midday spaces (e.g., Pleasant Hill, North Berkeley, El Cerrito del Norte).

How well do designated kiss-and-ride drop-off areas function?

Autos dropping off patrons during peak periods are supposed to stop in either kiss-and-ride or midday parking areas, usually located away from main entrances. However, most persons are dropped off in front of station entrances, which is legal only at Pleasant Hill and Rockridge stations, thus blocking drop-offs by buses, taxis, etc. and underutilizing intended kiss-and-ride drop-off locations.

What does the auto user experience on the path from parking lot to station?

Persons walking to the station entrances after parking their cars will find well-marked sidewalks and crosswalks. The visibility of station entrances from the lots is generally good.

At two-thirds of the suburban stations, parking lot users must cross a loop road which buses use to pull in front of the station entrance. Larger lots generate more pedestrian conflicts with loop road traffic. The problem is compounded when parking lot users cross the loop road at random locations rather than at established crosswalks as shown in Photo 2.4. A pedestrian overpass is presently being built between the parking structure and station to correct the existing problem at the Daly City Station. Few parking lot accidents involving pedestrians have been reported, however, despite these potential dangers.

PHOTO 2.4

CIRCULATION CONFLICTS ON LOOP ROAD (PLEASANT HILL)

Air pollution and noise do not appear to appreciably affect the auto user while in the parking lot or moving toward the station entrance. Low levels of carbon monoxide and noise were monitored in Phase I of the BART Impact Program, and BART passengers who were surveyed did not refer to station area air quality and noise pollution.

Visual impressions of station architecture and entrances are discussed under experiences of walking to BART. BART passengers surveyed expressed approval of station architecture, particularly at above-ground stations.

Is parking lot crime a problem?

Security is usually not a concern to patrons as they leave their cars or buses and approach the stations. Crime rates in BART parking lots and plaza areas continue to be very low even though BART now operates into late evening (Table 2.2). During early 1976, crimes and related incidents were reported to occur in BART parking lots and plaza areas at the rate of six per day, or about once for every 10,700 patrons. Crimes against individuals in BART parking lots, plazas, stations and trains are very rare--less than four percent of the reported incidents. At this rate, the typical patron will be a crime victim only once every 340 years!

Auto-related crimes, including car break-ins and thefts, are more frequent and have been increasing since BART operations began. Contributing factors are believed to be:

- Unattended character of lots (there are no lot attendants and at many stations, lots are not visible to station agents from the information booths)
- General increase in crimes in surrounding neighborhoods
- Infrequent police patrols.

However, as of early 1976, only one out of every 5,500 parked autos were subjects of crime. About 14,700 autos per day were parked in lots, with an average of about four incidents per day systemwide, or one per week in the typical lot.

Several factors may be helping to hold crime rates down. Most parking lots are flat and visible from adjacent streets; landscaping usually does not interfere with visibility, and lots are well lighted in the evening.

## BUS ACCESS TO BART

What signs are available to tell a patron which bus to take?

AC Transit bus and bus stop signs indicate which transit route to take to a BART station. On each AC Transit bus stop sign, a small rectangular "To BART" tag is attached beside the number of the route leading to the station. On the face of each bus, a circular panel light contains the words, "To BART." The words are back-lighted when the bus is enroute

Table 2.2
Comparison of Train, Station and Parking Lot Police Reports for Three Months (February through April 1976)[1]

| | Number of Incidents | | | | |
|---|---|---|---|---|---|
| | Train | Station | Parking Lot[2] | Other[5] | TOTAL |
| **Person Crimes** | | | | | |
| Assault/Battery | 1 | 6 | 3 | 3 | 13 |
| Strong-Arm Robbery | 0 | 3 | 5 | 1 | 9 |
| Purse Snatching/ Pocket Picking | 1 | 3 | 2 | 0 | 6 |
| Other Grand Theft | 0 | 0 | 4 | 4 | 8 |
| **Property Crimes** | | | | | |
| Petty Theft | 1 | 15 | 73 | 21 | 110 |
| Vandalism | 10 | 10 | 30 | 15 | 65 |
| Auto Theft and Burglary | 0 | 1 | 160 | 11 | 172 |
| Other Crimes[3] | 0 | 8 | 22 | 50 | 80 |
| **Miscellaneous** | | | | | |
| Fare Evasion | 0 | 103 | 0 | 44 | 147 |
| Drunkenness | 19 | 44 | 2 | 12 | 77 |
| Sex Offenses | 2 | 4 | 4 | 3 | 13 |
| Narcotics | 1 | 2 | 1 | 4 | 8 |
| Disorderly Conduct | 1 | 1 | 1 | 3 | 6 |
| Suspicious Persons | 45 | 74 | 12 | 57 | 188 |
| Other Miscellaneous[4] | 31 | 67 | 48 | 524 | 670 |
| Crime Not Specified Not Coded | 3 | 11 | 24 | 16 | 54 |
| TOTAL | 116 | 352 | 394 | 788 | 1,668 |

[1]Source: Metropolitan Transportatation Commission coded crime and miscellaneous reports from BART Police Services.

[2]Includes outside station and plaza crimes.

[3]Includes arson and weapon carrying.

[4]Includes reports of ill or deranged persons.

[5]Locations not specified.

to a station. These aids appear to increase BART patrons' confidence in using the feeder bus mode. The rider knows he has chosen the proper bus stop and boarded the proper bus. No similar signing exists for MUNI feeder bus users in San Francisco.

How good are the feeder bus services?

There is feeder bus service to every BART station, although it varies widely in frequency and coverage. With the opening of BART, AC Transit routes were reoriented to serve BART stations. Several Muni routes have also been modified to provide access to BART. In 1974-76, feeder bus service in the East Bay was extended to include central Contra Costa County (Walnut Creek, Lafayette, Orinda, Pleasant Hill), Tri-Cities (Fremont, Newark, Union City) and El Sobrante north of del Norte Station. Express bus service was provided to the Livermore-Amador Valley and the Pittsburg-Antioch area. Feeder bus service has also been expanded south of Daly City station to Pacifica, South San Francisco, and other communities in northern San Mateo County by San Mateo County Transit.

During commuter rush hours feeder bus headways range from 10-15 minutes downtown to 25-60 minutes average in suburban areas. Service is more limited during midday and evening hours. Three stations have no evening bus service: Daly City, Bay Fair and South Hayward.

BART users who rely on feeder bus service in medium density and suburban areas generally carry a bus time schedule or have a schedule available at home or work for easy reference. BART patrons using routes with headways of 15 minutes or longer try to time their trip to minimize waits at bus stops and BART stations. Although buses appear to be on time generally, feeder bus users would benefit by bus schedule adjustments to reduce waiting time at BART stations. Of course, the utility of coordinated bus scheduling depends on BART's ability to meet a fixed train schedule (see Chapter Four).

A 50% fare discount is offered on AC Transit and Muni feeder bus rides. In the East Bay the patron obtains a free bus ride when exiting the BART station. In San Francisco the rider purchases a two-part feeder bus ticket for 25¢ (half price); one part of the ticket is used to get to the station and the other is used upon leaving. Tickets are obtained before leaving the BART station. Few newcomers are able to understand this system.

Patrons appear generally satisified with the routing and headways of bus service. A relatively small number of complaints have been received by bus companies which are identified as providing bus service to BART. Most of these complaints deal with reliability, e.g., buses not on time, runs missed, etc.

Is it easy to walk from bus to station?

At most stations it is easy for first-time bus users to find their way to station entrances. Buses stop adjacent to entrances of subway stations and near the entrances of most stations with parking lots. Access to station entrances is safest at the 11 stations where buses stop directly in front of the entrances, since riders have no chance of mixing with vehicles. Buses stop outside parking lots at Ashby, Concord, Rockridge, Oakland West, Lake Merritt, MacArthur and Coliseum stations.

## WALKING TO BART

### How does one know which route to take?

Pedestrian trips to subway stations are most common in downtown or medium density areas. Pedestrians walking in downtown areas other than Market Street in San Francisco will encounter directional signs at major pedestrian intersections within a two- to three-block radius of the BART stations (Photo 2.5). Some patrons have had difficulty locating Market Street station entrances without the aid of directional signs.

The pedestrian's selection of a route to the station is based on shortest walking distance; avoidance of street crossing delays and steep slopes or steps; safety (e.g., width of a sidewalk, traffic hazards); security (e.g., lighting, visibility, loitering), and amenities (e.g., interesting shops, landscaping). Market and Mission Streets in San Francisco and Shattuck Avenue in Berkeley were each attractively renovated in the vicinity of BART stations. The beautification undertaken in association with BART construction enhances the pedestrian environment.


PHOTO 2.5

DIRECTIONAL SIGNS TO BART STATIONS ON NEARBY STREETS

Are the stations easy to identify?

Above-ground stations are generally visible several blocks to a half-mile or more from the station, although it is not possible to identify a station name or BART symbol at that distance. The station architecture, the parking lot and guideway contrasts with surrounding structures, in scale, color, or texture, making it easier for the pedestrian to locate. Station names and the back-lighted BART logo are visible within one block of most stations.

In downtown areas where BART is below-ground, station entrances are visible perhaps a block away. Station names are not easily visible.

At night, lights on above-ground stations, in station parking lots and at subway entrances help guide pedestrians to the stations.

How well do pedestrian plazas function?

Small public plazas built in association with BART, e.g., Hallidie (at Powell Street), Montgomery, and Civic Center in San Francisco, provide handsome focal points for urban activities such as relaxation, street artists, and musicians. Once in the plaza, the patron can usually recognize the entrances to BART. Riders surveyed find these plazas and other station design features very attractive entryways to the system.

Although crime to persons in plaza areas continues to be very low, patrons may be annoyed by loiterers in Hallidie Plaza at the Powell Street station. According to a recent article in the San Francisco Chronicle, neighborhood residents and merchants have charged that the terraced plaza is a haven for rowdies, hooligans and drunks. However, the actual situation is somewhat more complex.

Hallidie Plaza adjoins the main downtown terminus of the city's popular cable car lines, a location frequented by many tourists. The San Francisco Convention & Visitors Bureau has recently established an information office in the plaza itself to respond to the needs of these visitors. The location also borders the city's busiest shopping district; the largest department stores are all within two blocks. (Photo 2.6).

However, on the plaza's opposite side begins a less attractive area of fringe commercial uses (discount stores, pawnshops, supply houses, X-rated movies, etc.) and low-rent residential hotels. This area is home to many retired and unemployed persons for whom the Plaza is almost the only accessible and comfortable "neighborhood park". Some of these people are destitute, and alcoholism is not uncommon among them. In addition, the relative affluence of the tourists and shoppers around the Plaza is an inducement to those of the area's residents and others who make their living by panhandling and pickpocketing. All of this existed even before the Plaza was built.

The resulting social situation is inherently one of conflict among users, even though most of them -- including the low-income residents -- have legitimate needs and a right to be there. Despite this conflict the Plaza is generally well used by people of all kinds, including tourists. As already noted, crime is not a major problem. However, in future systems some consideration should be given to the potential for such conflicts and related problems. Location rather than design seems to be the issue; in this case it appears that the Plaza provided a new focus for already-existing conflicts in the area, rather than creating new ones.

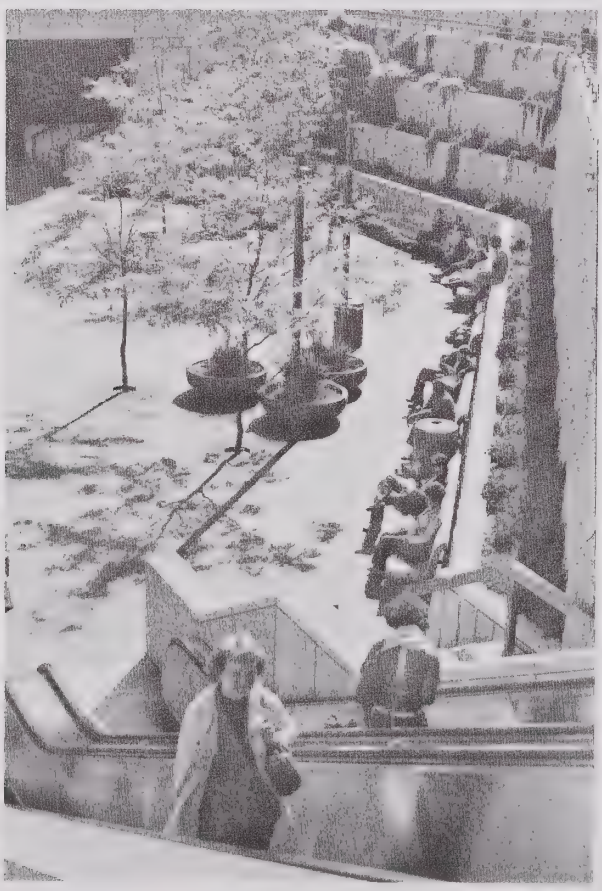

PHOTO 2.6

HALLIDIE
PLAZA
(POWELL STREET)

## CHAPTER THREE

## INSIDE THE STATION

### GENERAL CHARACTERISTICS

This chapter is concerned with the stage of the BART patron's trip between entry into the station concourse from outside and exit onto the station platform to wait for the BART train. The platform and train, as well as the system exit procedure at the end of a trip, are covered in succeeding chapters.

BART defines the concourse as "a transition area between station entry points and the stairs or escalators to train platforms. It functions to separate the activities involved in the complex process of moving large numbers of people through the station. Space is provided within the concourse for the entire fare collection process, the station agent, directional and information signs, and various amenities for passenger needs and comforts." (Manual, Sec. 1.7).

The concourses in different stations vary widely in size and design details such as finish materials and colors. Size is determined partly by the station's expected peak period patronage, but also by physical constraints such as right-of-way width (particularly in subway stations). In general, however, the concourse spaces are very large and open when measured against the needs of their patronage loads (Photos 3.1 and 3.2).

Several of the San Francisco stations along Market Street have two nearly independent concourses, each fully equipped and staffed. These are to handle the particularly heavy patronage expected there. In addition, in this area the concourses serve two purposes, since the new San Francisco Municipal Railway (MUNI) streetcar subway platforms are just below them and above the BART tracks. Patrons of both BART and MUNI (when it begins subway operation, probably in 1978) will use the same concourse areas.

Despite their many differences, the concourses are also similar in some important respects. In particular, the organization of the main activities -- obtaining information, buying tickets, and passing through the fare gates toward the platform -- is nearly identical in all stations. All key activities are typically grouped together or nearly so, with the ticket and change machines, station agent's infomation booth, and fare gates arranged in a fairly consistent manner. Other facilities, however, such as entry and exit stairs, escalators, elevators, restrooms, advertising, telephones, seating and light sources, are unique for each station.

PHOTO 3.1

SUBWAY STATION
CONCOURSE
(EMBARCADERO)

PHOTO 3.2

GROUND LEVEL
CONCOURSE
(DALY CITY)

ENTRY

How does the patron get into the station?

Entranceways to BART stations vary considerably. Most are easily seen and readily accessible to the arriving patron. (Photo 3.3) They provide protection from the weather, and are usually well integrated with the adjacent area which serves as a pedestrian collector. Stations in which the entranceway is covered by another structure such as a freeway (Rockridge and MacArthur stations, for example) tend to be somewhat dark during the day, but otherwise the entrances appear well-lighted and inviting.

A few stations have concourse levels at-grade and the train platform at a subway level. Entrances to these stations are either directly from the street (e.g., Balboa Park, Glen Park) or a parking lot (e.g., Ashby, North Berkeley). This configuration allows more light into the station and enables patrons to see into the facility before entering. (Photo 3.4)

There are two types of entrances to BART subway stations. The most common begin directly at the street and take the patron underground via escalator, elevator or stairs. Only a guard rail and small standardized "BART" signs are visible from the street, making this type of entrance somewhat difficult to find. In downtown San Francisco,
"BART" signs are visible from the street, making this type of entrance somewhat difficult to find. In downtown San Francisco, BART signs are absent, making it even harder for the new or infrequent user to identify the entrance. In many of the 14 subway stations, it is impossible to see inside from the street, and there is no shelter from rain and wind until the patron nears the bottom of the stairs.

Plazas, of varying shapes and sizes, have been built in conjunction with several BART stations. These adjacent plazas provide an intermediate area between the sidewalk and the BART station, making entranceways more inviting. Plazas built in conjunction with subway stations work best when designed intentionally to direct movement from the street into the station, as in Hallidie Plaza at the Powell Street Station (Photo 3.5). In contrast, at the Mission Street stations (Photo 3.6), the entrances from the plazas are at the rear, away from the street and major sidewalk pedestrian flow. It is not immediately evident to the stranger that these plazas are connected to BART entrances. However, all the plazas serve to some degree as activity centers, adding variety and life to the urban area around them.

Regardless of the station type, each entranceway leads directly to the ticketing areas on the concourse level. Safety, convenience, and comfort were BART's primary requirements for its vertical circulation elements (Manual, Sec. 20). All stairs are built of noncombustible materials, and have non-slip treads, as well as handrails on both sides. In most cases, there are no more than 14 risers in any one run of stairs and no more than three runs in any one straight stair. Minimum width of stairs for public use is 5-1/3 feet, and unobstructed space in front of stairs is provided.

PHOTO 3.3

STATION
ENTRANCE
(SOUTH HAYWARD)

PHOTO 3.4

CONCOURSE
(GLEN PARK)

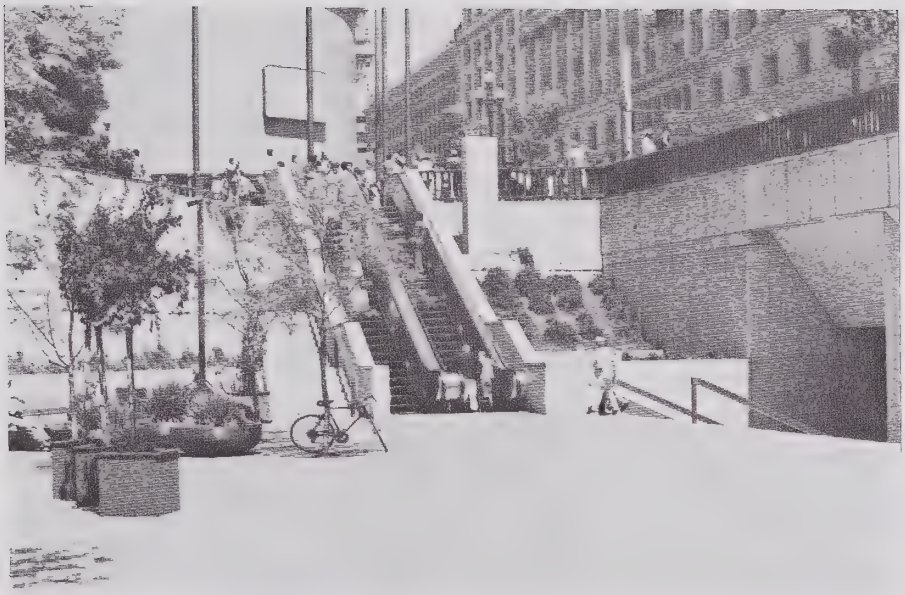

PHOTO 3.5

HALLIDIE PLAZA
(POWELL STREET)

PHOTO 3.6

STREET PLAZA
(24TH AND MISSION)

Escalators are of the heavy-duty, reversible type, operating at a speed of 120 feet per minute. On a 48" (normal) width escalator, design capacity is 135 persons per minute. Entry escalators are typically not sheltered from the weather, but are designed to be weatherproof. At least one elevator is provided at each subway station for use between the street level, concourse and platform. The elevator is activated by the station agent, in response to a signal from the patron. The agent controls its use via telephone and television camera. In many stations elevators were not part of the original station design, but were fitted in as well as possible late in the program.[1] Often this has resulted in their being inconvenient to the user.

## ORIENTATION

### Is it clear where arriving persons should go and what they are to do?

The overall concourse layout is similar for all BART stations. Thus, once patrons are familiar with the layout and operation of one station, they seem to feel comfortable in all stations. The key factors allowing for easy orientation of most passengers are: (1) the central location of the station agent's booth in relationship to fare gates and other functional devices and (2) the circulation patterns encouraged by BART design.

Depending on station size and patronage, the ticket vending and fare gate function is divided into one, two or three "centroids", each supervised by a station agent who occupies an information booth between the free and paid areas. The booth is clearly visible from all parts of the concourse, and easily recognized by passengers seeking assistance because of its consistent placement within the BART station and its distinctive and standardized design of stainless steel and glass (Photo 3.5). Fare vending activities, graphic displays and gate consoles are usually located within close range and in view of these booths.

Since circulation in transit stations is usually determined by areas of constriction or confusion which slow movement, BART architects used basic principles as guidelines to minimize obstruction to passenger flow (Manual, Sec. 1.6). These were:

- The natural flow of passenger movement is to the righthand side.
- Passenger movements in opposite directions should be kept separated as much as possible.
- Dead end conditions should be avoided.
- Both ascending and descending movements along a single path should be avoided.

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[1] Elevators are discussed in detail in Chapter 7 since they were put into the stations primarily to serve handicapped persons.

PHOTO 3.7

STATION AGENT'S BOOTH (DALY CITY)

Observation of circulation patterns reveals that passenger movement through the concourse is smooth for the commuter, the primary user of the system. However, infrequent riders surveyed have difficulties in operating machines and making their way to and from trains, especially during crowded rush periods.

Is it easy for a patron to get the information he needs?

There are several sources of system information available in each station, including graphics, brouchres and BART personnel. The station agent is, however, the most important source of information.

Station agents are on duty at every station during operating hours to assist travelers. They have telephone access to Chinese and Spanish-speaking persons at BART headquarters for patrons who cannot speak English between 9 a.m. and 5 p.m. The duties of agents include services such as system information, emergency first aid, assistance to handicapped patrons, expediting flow through the fare gates in busy periods, handling lost and found inquiries and general complaints, admitting patrons to restrooms, and assuring the station's safe and smooth operation in general.

BART station agents are in general friendly and very helpful. Sometimes in busy stations during rush periods especially, it was observed that there were not enough of them (typically one or two) to meet the needs of patrons. In those cases, patrons who needed to use restrooms or elderly/handicapped patrons needing elevators would have to wait while agents dealt primarily with facilitating the fare collection and exit/entry of patrons. Also during their twice-daily break periods, agents working alone in some

stations must leave their station unattended for 20 minutes or so.

Station agents interviewed stated that much of their time is taken answering questions about fares, operation of the fare collection equipment, how to get taxis, and other similar matters. Ideally, the brochures and graphs should answer all or most of these questions sufficiently. Station agents can be highly imaginative in their attempts to cope with the public; some even write and post localized system information in an informal manner (Photo 3.8). However, there is no official mechanism to facilitate this. BART patrons surveyed, especially first time users, stated thay utilize station agents for information and assistance more than any other means of system orientation. This was confirmed by the agents.

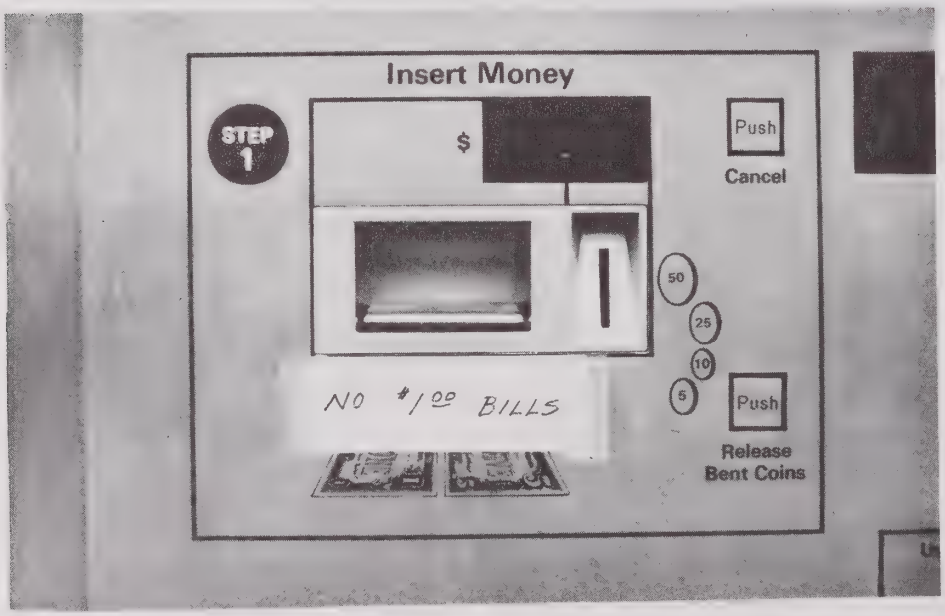


PHOTO 3.8

HANDWRITTEN INFORMATION ON TICKET MACHINE

The brochures are concisely written, giving all the information a patron needs to use the system. "All About BART" is printed in three languages (English, Chinese and Spanish), although only the English version is displayed in most stations (the others are available from the station agent). Also, a booklet called "BART and the Handicapped" is available for handicapped users.

Several graphic devices are used. There are display maps at all stations in the concourse area and often on the platform level. These consist of three system maps:

- The geographic Reference Map showing areas served by BART.
- The Route Map showing BART lines, transfer points and other operational aspects of the system.
- The Local Map which shows the locale around the station, bus, and other transportation connections, and points of interest.

These maps are approximately 4' x 4' in size. At the Powell Street Station (the main tourist-used station) larger versions, approximately 12' x 12', are found at the concourse entrance (Photo 3.9).


PHOTO 3.9-

MAP DISPLAYS ON CONCOURSE (FRUITVALE)

None of the station graphics appear in any language other than English. This hampers many members of San Francisco's large immigrant population as well as non-English-speaking tourists. Internationally understood symbols have been extremely useful in European transit systems in dealing with similar problems.

In addition to the maps there is a four-foot square information display entitled "All About BART" (Photo 3.10), signs on station agents' booths and in other prominent places indicating "last night train schedules" to all destinations, and instructions on ticket and change machines indicating how to use them.

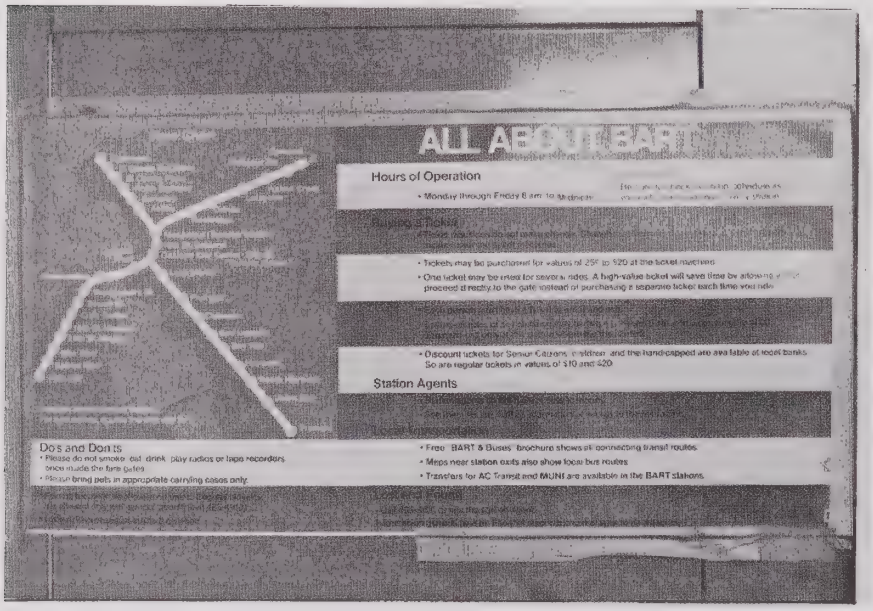


PHOTO 3.10

"ALL ABOUT BART" CHART (GLEN PARK)

Directional Signing is limited. Since the original intent of the basic station layout was to obviate the need for signs as much as possible,[1] both directional and identifying signs were deliberately minimized. They were, however, made uniform throughout the system with the option of adding more if necessary. These signs include BART system maps (back-lighted) at station entrances and concourse directional signing.

FARE COLLECTION

Is the fare collection system quick and easy to use?

BART's fare collection system is easy to use once the patron is familiar with the procedure, but initail use is often confusing. Reasons include (1) the inherent complexities of distance-varying fares and (2) unclear instructions in use of the system components.

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[1]McCutchen, W.R. "Passenger Design Standards for BART Stations," proceedings of the ASCE Man/Transportation Interface Joint Specialty Conference, Washington, D.C. (Spring, 1972), p. 197-233.

The Automatic Fare Collection (AFC) system consists of four main elements:

1. Ticket machine -- enabling patrons to purchase tickets in any amount from 25¢ to $20.00.

2. Change machines -- located adjacent to ticket machines and capable of changing coins and $1 bills only.[1]

3. Automatic fare gates -- open and admit patron to paid area upon insertion of ticket; at exit, magnetically processes tickets to determine fare, prints remaining value, and opens to allow patron to exit to the free area. Directs patrons to "Addfare" machines nearby if ticket value is insufficient.

4. "Addfare" machines -- located inside paid area near ticket gates. On ticket insertion it will compute the fare for the trip just taken, read the value of the ticket, and indicate additional fare needed to open gates.

Aside from the information booth and directional graphics, the fare vending and change-making machines are the most prominent features in the free area of the concourse. At least one vendor and one changer are located in the vicinity of each set of entrance gates. The number of ticket vendors installed was based on a formula of one vendor for every 75 people expected to be boarding during the peak five minutes (Manual, Sec. 11.7). Consequently, no station has less than two ticket-vending machines, and the Montgomery Street Station, the system's busiest, has 27 ticketing machines. Initially, the ticket and change machines were separate. Now, however, combination machines are being installed gradually following their introduction with the opening of the Embarcadero Station.[1]

The ticket-vending and money-changing machines, or signs indicating their location, are easily visible upon entering the concourse (Photo 3.11) in all stations. The machines are designed for use by a maximum of six persons per minute. A comparison of this design specification and the above formula for estimating the need for ticket-vending machines indicates that designers expected that a majority of the patrons boarding during the rush periods would not need to use the ticket vending machines. In the downtown stations an 8-foot-long queue space is provided at the machines; in the suburban stations a six-foot space is provided. However, BART patrons surveyed in this study complained about the crowds that develop around the ticket and change machines during rush periods.

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[1]The new combination ticket/change machines also have the capacity to make change for both $1 and $5 bills.


PHOTO 3.11

TICKET AND CHANGE MACHINES (SOUTH HAYWARD)

Any station entrance employing fare gates (such as BART's) or turnstiles must have:[1]

- o A sufficient number of fare gates to satisfy the peak loads and
- o Adequate queue space in front of fare gates to allow for random fluctuation in short term peak loads.

The fare gates were intended to process 40 persons per minute (Manual, Sec. 11.9). At least three fare gates were provided at any single gate location -- one for exiting, one for entry and a third for the direction of major flow or as an emergency standby. Presently, no station has fewer than four gates, and the Montgomery Street Station has 37 gates. Emergency queue space is provided on either side of the battery of gates in case one or more of the gates fails during the peak hours. In the busier downtown stations, 20 feet of queue space is provided; in the suburban stations 15 feet is provided.

An emergency exit gate is also provided at every barrier adjacent to the ticket gates. These gates have panic release hardware and, to discourage misuse, audible alarms. There is also a service gate to each paid area, which can be used by handicapped patrons, maintenance and service staff, and emergency crews. In some cases the emergency gate and service gate are combined.

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[1]Source: BART Maintenance Planning Department Report #M14001.

Queue space appears adequate at most stations, and the number of fare gates seems to be more than necessary in most cases to handle present peak loads. However, these are problems at some of the suburban stations. For example, at the Lafayette Station a queue backs up in the paid area from the stairs and platform during the peak periods. According to BART station agents interviewed, the most frequent AFC problems causing patrons delay are those of understanding the ticketing procedure and the fact that most change machines cannot handle bills larger than $1.00.

It is important to note that BART tickets are available at banks as well as in the stations. The bank service is often shown on the destination signs in stations and it is described in BART information brochures.

Is the system reliable?

The AFC system is not always reliable. Table 3.1 shows the average monthly number of failures over a recent 12 month period. This indicates that, on the average, every machine has a high probability of failing every month. The money-changers and ticket machines are particularly unreliable, each failing over twice a month on the average. Most of these failures, however, are simple jammings and are often quickly freed by the station agent without necessitating a repair call. One out of every ten failures requires maintenance department repair work. However, on any given day about 95 percent of the fare gates are working properly.

Table 3.1
FAILURE RATES FOR AFC EQUIPMENT, MARCH 1975 - FEBRUARY 1976

| AFCS Component | Monthly Average | Failures High | Failures Low | Total Components on the System | Percent failure per month |
|---|---|---|---|---|---|
| Fare gates | 183 | 260 | 124 | 304 | 60% |
| Money-changers | 351 | 465 | 233 | 143 | 245% |
| Ticket vendor | 252 | 329 | 197 | 142 | 177% |
| Addfare machines | 43 | 61 | 31 | 72 | 60% |
| Transfer Dispenser | 51 | 100 | 27 | 105 | 49% |

Is the AFC system hard to evade?

No. According to the BART Manual (Sec. 11), "Barriers between the paid and free areas are required to be a type that will give appropriate security for the area to be protected." Contrary to the intent of these standards, fare evasion has been the most frequent single offense on BART. It is facilitated by the low (32-36") height of the barriers between the free and paid areas. Fare evasion appears to be occurring most often at times when station agents must leave the information booths and at stations with fare gates out of view from the agent's booth (12th Street-Oakland, for example).

SAFETY AND SECURITY

How likely are accidents in the concourses?

Within stations, accidents are more likely to occur on level changes than on flat areas. These accidents are usually falls. However, most occur in the paid areas inside the station, rather than at the entrances. It is important to note that the overall accident rate at BART stations is low; about 25 accidents per million passengers. Over a three month period (February - April, 1976) 113 reported accidents occurred on level changes (72 on escalators, 37 on streets and 4 in elevators) in BART. Most of them were falls.

The following factors have been cited by BART officials and other observers at some stations, and may be a cause of accidents.

- Escalator Markings -- BART has three types: markings on the front of the step, markings on the rear of each tread, or none at all. the front markings appear to be most helpful to the user.

- Escalator Speed -- BART's are faster than those in most department stores (120 vs. 90 fpm), necessitating quicker reactions by users. However, BART officials pointed out that slower escalators might be more dangerous as more people would want to walk on them rather than standing still.

- Stairs -- BART's cement and terrazzo stairways are smooth surfaced, even though provided with non-slip safety taping, and can be slippery during rainy periods.

- Children Playing -- on escalators and stairs is a frequent occurrence at some stations, and may be a cause of accidents.

- Use of alcohol, drugs and medications -- this is a frequently cited cause of accidents.

Crowding was not found to be a contributing factor in most accidents even though the majority of accidents occur during peak periods.

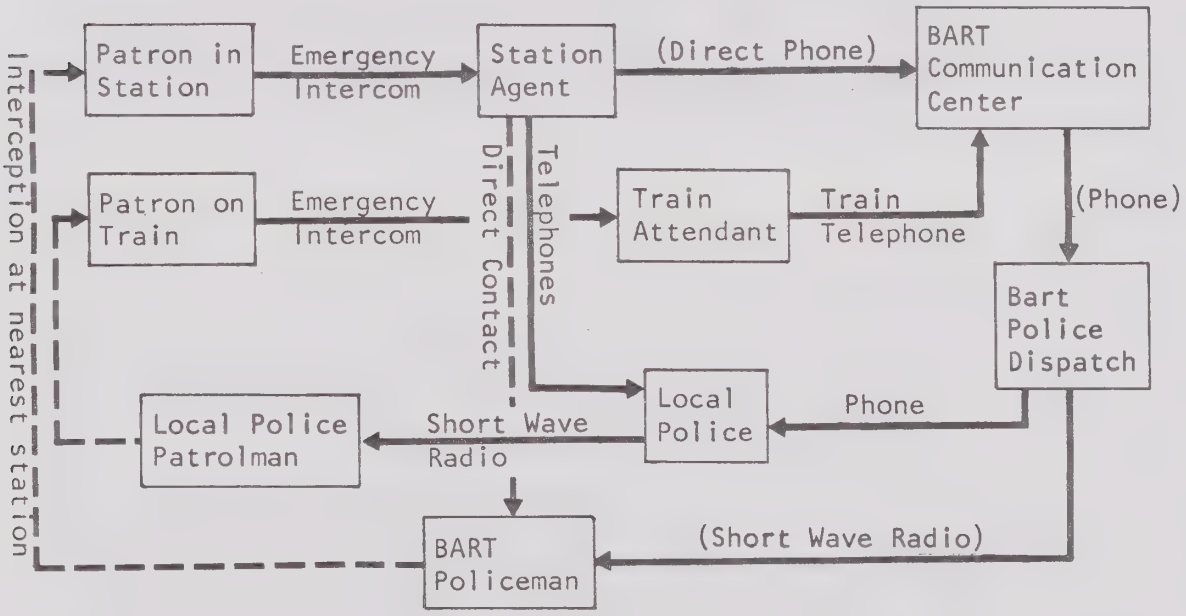
Is emergency help available if needed?

In case of an accident, station agents are usually available to provide emergency help or call outside ambulance services if necessary. They can be reached by using one of the phones of the emergency intercom system located both in the station (on platforms, next to elevators, in restrooms, etc.) and on the train. The chain of communication set in motion is as shown in Figure 3.1.

After a patron communicates a need, the station agent or train attendant will transmit the communication further depending upon the needs of the situation. Although this seems complex, BART police officials stated that the total communication time from a station agent or train attendant

to the nearest patrolman is only approximately 1-1/2 minutes. However, the time for a BART patrolman to get to the scene depends upon his location and can take as long as 20 minutes. Consequently, BART has a complete working agreement and direct communication with local police along its right-of-way. In situations requiring immediate assistance, local police patrols can respond to a call at any station in 4 - 5 minutes, which is comparable with police capabilities in most urban areas. According to BART officials, the use of local police in this way was only necessary two dozen times or so since operation began.

Figure 3.1
EMERGENCY COMMUNICATION IN BART SYSTEM AND DISPATCH OF POLICE HELP




Are there any BART police around?

The BART police force is fairly "visible" on the system. On any given day, an average of five uniformed and 4 to 6 plainclothes officers are circulating in the BART system (evening shift has 12-14 officers in the field). If there are fewer available on patrol, they ride from one station to another in autos. Additional uniformed personnel ride the trains. The reasons train patrol is foregone when police are short-handed are the following:

- Trains cannot be reled on for quick response to calls.
- Additional emergency equipment is available in patrol cars that isn't available in trains or stations.

- Officers are quite often required to respond off the system to complete investigations.

The plainclothes officers form a mobile unit that responds to problems shown in BART's crime statistics or pointed out by other police personnel. Recently, uniformed police have changed their dress from optional blue blazers to the traditional military look. According to police spokesmen, people did not believe that persons in blue blazers were police and in gneral the police were less visible.

How much crime occurs in BART stations?

Although more offenses are reported inside the station than elsewhere on the BART system, most of these are not crimes to persons. Fare evasion is the leading offense followed by drunkennes (refer back to Chapter Two, Table 2.3). The number of reported incidents is small. According to BART police officials, crime frequencies in the BART system are generally lower than in the adjacent municipalities or on other transit systems. Data to support this were not readily available.

## ENJOYMENT

Are the stations aesthetically pleasing?

Aesthetic appeal in the concourse area of the station, and to varying degrees in other areas of the station, is achieved by basic design form and the use of various materials and colors. Interest if further enhanced by works of art placed by BART in the stations.

The floor and wall materials are distinctive for each station, and may be a primary means for their identification by patrons. The 12th and 19th Street stations in Oakland are remembered for their highly distinctive use of red and blue brick, the Embarcadero station for its extensive use of marble, and the Powell and Montgomery Street stations for their black and white ceramic tile. Others are equally distinctive. Floor materials frequently used include terrazzo, brick pavers and tile. Wall finishes run the gamut from exposed concrete to granite, marble and stainless steel.

Nearly half of the stations display some form of art work, primarily in the concourses. Through BART's station Art Program, it is planned that eventually at least one work of art will be placed in each of the stations. The art works include murals, multi-colored glass mosaics, tapestries, paintings, and sculpture. Many of the works are very large (the mural in the Orinda concourse is 10 feet by 100 feet) and create visual focal points within the concourse space (Photo 3.12). The bright colors enliven the more subdued hues of the station. To help promote new works and suggest artists, an Art Council has been established to work with the BART Board of Directors in completing the Station Art Program.

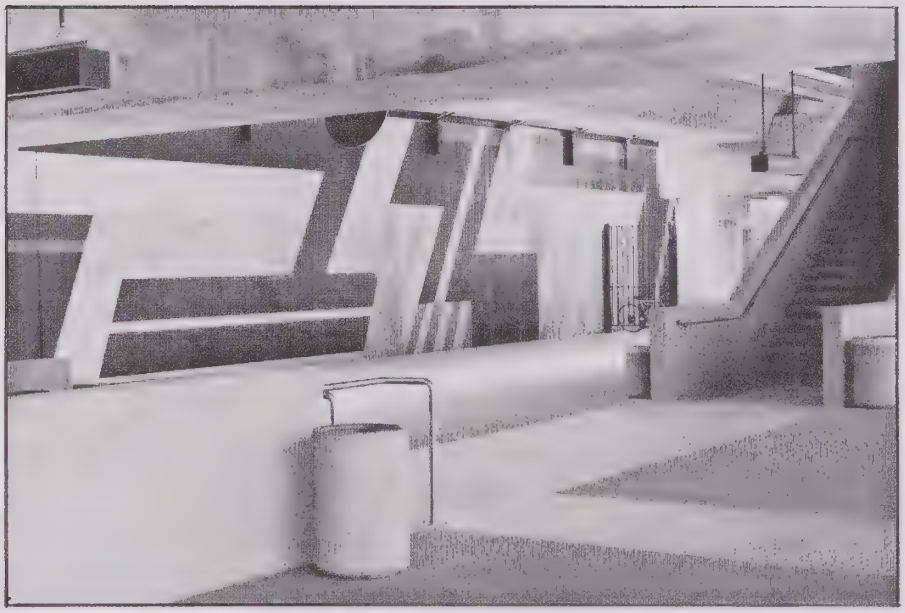


PHOTO 3.12

ART WORK
(ORINDA)

The Art Council also monitors the quality of display advertising in the BART facilities. In some ways this might be considered the most extensive and visible "art" element in the station. Early in the design of BART, it was recognized that limited, controlled advertising could act as a positive design element of the system. Consequently, the use of advertising to provide color, and, of course, revenue, was encouraged, and policies were established regarding the placement, size and content of advertising. Advertising is found affixed to walls and in free-standing displays (kiosks, panels). It is placed adjacent to areas of heavy traffic, generally in a way that does not obstruct flow. In most cases, the advertising is complementary to the station's overall aesthetics (Photo 3.13). No public complaints about advertising were found, either in BART's records or in this study's interviews with patrons.

Lighting significantly alters the appearance and design quality of stations. Its use has been specified (Manual, Sec. 1.28) as a design element to designate specific areas such as points of vertical circulation, fare collection, waiting and concession areas, and also to insure clear visibility and provide a cheerful atmosphere. Lighting design varies from station to station but fluorescent tubes are used throughout, producing about 35 foot candles with somewhat greater intensity at points of vertical circulation.[1]

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[1]Maulé, T. Station Design and Graphics for BART, paper presented at the annual meeting of the American Transit Association, San Francisco (April, 1971), p. 10.

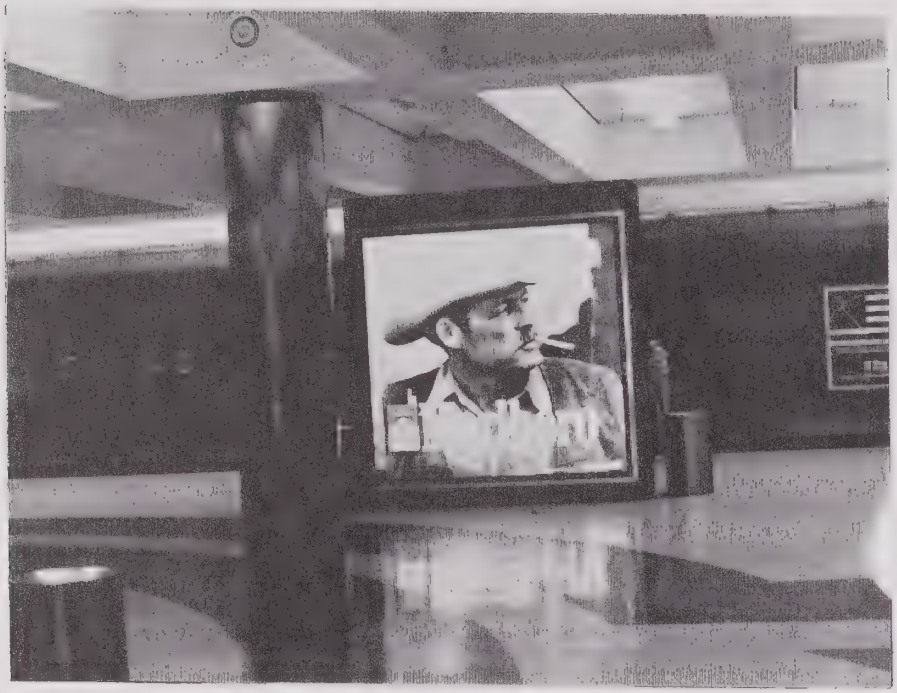


PHOTO 3.13

ADVERTISING
DISPLAY
(POWELL STREET)

Perhaps the most successful lighting effects occur in the Balboa Park and Glen Park subway stations, where the ceiling was left partially open, exposing a portion of the platform and all of the concourse level to natural skylight (Photo 3.14).

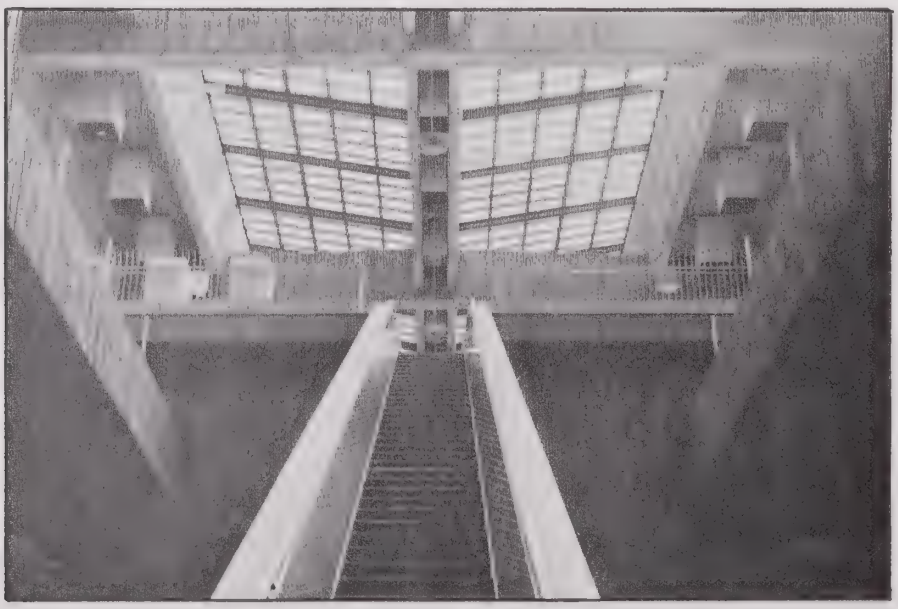


PHOTO 3.14

LOOKING UPWARD
FROM PLATFORM
(GLEN PARK)

Are the BART stations well maintained?

From the very beginning BART designers recognized the need for good maintenance in creating and maintaining a favorable image of the BART system (Manual, Sec. 1.30). In the station design and the use of materials, ease of maintenance was a prominent criterion. The level of cleanliness found in the stations is impressive. In part, this is a result of having avoided the use of spaces (e.g., nooks and corners) which would attract dirt and litter and be difficult to clean. Also, surfaces which might require more care (e.g., glass) are usually located so that passengers do not normally come into direct contact with them. Litter containers are located throughout the station, particularly in waiting areas, near vending machines, on the platforms and along station entrance and exit paths. Maintenance elements, such as custodial and trash rooms are typically inconspicuous within the total station design.

Over one-third of the patrons surveyed in this study volunteered favorable comments on the appearance of the stations, with emphasis on the general cleanliness and lighting within the station. There were no negative comments.

## NON-TRAVEL SERVICES

What services are provided?

Because it was assumed that trains would run more frequently than they do, stations were designed on the premise that patrons would be in them for a very short time. Consequently, only a few non-travel services are provided. Concessions, toilets, telephones and occasional benches or separate seats are located throughout the concourse, and they add to the confort and convenience of the passengers without directly relating to the trip itself. Usually, they are located near the flow of passenger traffic without creating an obstruction.

Concession facilities consist primarily of automatic food, cigarette and newspaper vending machines in most stations. Two of the downtown stations (Powell and Montgomery) also have manned concession stands (Photo 3.15), but these are presently closed following the financial failure of the initial concessionnaires. The operation of these booths enhanced the station and BART is actively seeking operators. One of the problems with the concession facilities are their locations. They are in the free areas of the stations where patrons spend little time.

Public telephones are found in the concourses as well as on most (although not all) platforms. There are few, if any, benches or seats on the concourse. Seating at the concourse level was optional at the discretion of the station architect. Most chose to provide no or very minimal seating, since it was felt that people would not spend significant periods of time in the stations. Lockers are found in a number of the downtown stations, but for security reasons (in reaction to bomb threats) they are not presently used.


PHOTO 3.15
CONCESSION STAND
(MONTGOMERY STREET)

Mailboxes have been installed recently in all stations unless they were already conveniently located on adjacent streets. Community bulletin boards are being considered at suburban stations to inform BART patrons of local events.

There are two small restrooms in every station. These are usually located in the free area of the concourse. They are kept locked in most cases and can only be opened by key or a signal from the agent's booth. Despite a few complaints from patrons surveyed as to the inconvenience of having to ask the agent for entry, the system was observed to work quite well. Gaining entrance is rarely a problem. They are generally quite clean, and there is a feeling of security in being able to lock the door and have complete privacy. In contrast, public transit systems in some other cities have had to close their restrooms because of frequent crimes to persons (New York City subways, for example). Other new transit systems are not installing restrooms (the Metro in Washington, D.C., for example).

BART maintains an excellent lost and found system. According to officials, approximately 60 percent of the inquiries produce recoveries. The BART Passenger Service Division maintains a complaint department for the purpose of providing the public with a means to voice complaints and to provide the District with passenger feedback on the effectiveness of services and facilities. Over a six month period (October, 1975 - March, 1976) more complaints were received about train delays than any other condition. Complaints of crowding, difficulties with BART staff, and parking lot restrictions were also numerous.

# CHAPTER FOUR

## ON THE PLATFORM

### GENERAL CHARACTERISTICS

All platforms are either directly above the concourse in the 20 above-ground stations, or directly below in the case of subway stations. The primary design constraint for the platform was that it be 700 feet long, in order to accommodate a ten-car BART train.

Platform configuration varies somewhat depending upon site-specific design needs. Subway station platforms are all of the center-loading type, except for the Oakland 12th Street and 19th Street platforms. These platforms are of a two-level, side-loading design in order to stay within the right-of-way of the narrow street. The width of the subway platforms varies from 22-1/2 feet to 35 feet, with at least eight feet between obstructions (e.g., a column or an escalator) and the edge of the platform.

Open areas for patrons take up approximately 70 percent of the total subway platform space. The remaining space is filled by escalators, stairwells, an elevator, 2-foot-wide warning strips, columns, benches, telephones and trash receptacles (Photo 4.1). At the Montgomery Street station, the most heavily used station in the system, the 35-foot-wide platform can accommodate up to 1,500 passengers at a time.

The four subway stations along Market Street in downtown San Francisco (Embarcadero, Montgomery, Powell and Civic Center) include a separate MUNI platform sandwiched between the concourse and BART platform levels. Since the MUNI system has not yet been put into operation, the only effect on BART travelers is a somewhat longer vertical descent to the platform.

Above-ground stations have either side-loading or center-loading platforms. When the sets of track must be close together (about 14 feet from center to center), usually because of space limitations, a side-loading scheme is used. Here the platforms are approximately 18 feet wide, for the middle 280 feet, narrowing to about 12 feet for the remaining 210 feet at each end. When the sets of track can be further apart (usually 36 feet from center to center), a 25-foot-wide center platform configuration is used. There are ten above-ground stations of each type.

As with subway platforms, above-ground platforms also include such elements as stairwells, benches, directional signs, etc. Approximately 75 percent of the total space on these platforms remains free for use by the passengers (Photo 4.2).


PHOTO 4.1

SUBWAY STATION
PLATFORM
(24TH AND MISSION)

PHOTO 4.2

ABOVE GROUND
STATION PLATFORM
(SOUTH HAYWARD)

## ENTRY TO PLATFORMS

### How do patrons move from the concourse to the platform?

Patrons move from the concourse to the platform via elevators, escalators, and stairs. Small stations usually have one or two escalators conveniently located near the fare gates. In larger stations, there can be as many as six, although it is sometimes necessary to walk long distances to an escalator going in the desired direction. In addition, the direction of escalators is often uncertain, because they are reversed to fit major movement direction. This is a major complaint of patrons surveyed, although it would seem that if direction was fixed, congestion and perhaps even greater complaints would be inevitable. Stairways are always available but are not the major mode of movement in larger stations, perhaps because of the long distances to ascend or descend. Only one elevator is provided in most stations. At most stations elevators are obscurely located.[1]

## INFORMATION AND ORIENTATION

### Which train should the patron get on?

Although there are electronic signs suspended from the platform ceilings indicating final destinations of trains coming in on each track, the trains themselves are unmarked. Final destination of each train is displayed on the electronic signs (TDS: Train Destination Signs) as the train approaches the platform (Photo 4.3). Announcements of arriving trains are sometimes made over the public address system, but not on a regular basis. Also, announcements cannot be heard by persons at the ends of platforms in above ground stations. Station agents interviewed noted that new patrons sometimes wait for their particular station destination to appear, unaware that only the end-of-line destination is displayed. Also because the TDS units are used to display other information between train arrivals (time, advertisements, news, etc.), new users of the system sometimes do not pay attention to the destination announcements when they do appear.

### Where should the patrons stand to board the train?

Patrons need to know the lengths of trains and preferably the exact location of doors when trains stop. Although train lengths are generally short during the day (3 - 4 cars) and long (8 - 10 cars) during commuter hours, they vary

[1]Elevators are discussed in detail in Chapter 8, BART and the Handicapped.


PHOTO 4.3

TRAIN DESTINATION SIGN ON PLATFORM (DALY CITY)

unexpectedly quite often because of the unreliability of equipment. BART recently began to indicate whether trains are long or short on the TDS, as follows:

| (destination) | (destination) |
|---|---|
| SHORT TRAIN - USE CENTER PLATFORM | USE ENTIRE PLATFORM |

Previously, passengers would often be waiting at the ends of the platform, expecting full-length trains, and would have to run to the center to board when short trains arrived.

Exact locations of train door stops are indicated on only a few platforms by markings in the edge warning strips (Photo 4.4). However, the location is constant and commuters learn where to stand and form orderly lines during rush periods. In stations where trains serve more than one destination from the same track, patrons step out of line to board and those waiting for another train close up the ranks.

Although orderly lines are encouraged by consistent location of trains in stations, queuing patterns that form in some stations may result in poor use of platform space. In a previous study[1], two distinct queuing patterns were observed on downtown San Francisco station platforms. One is a pattern of transverse queues formed spontaneously by commuters who know from experience the exact location of train door stops; the other

[1]By De Leuw, Cather for the Denver Regional Transportation District, 1975.

PHOTO 4.4

PLATFORM EDGE MARKING WITH ARROWS INDICATING TRAIN DOOR STOP LOCATIONS (LAFAYETTE)

is an elliptical crowding pattern created when patrons are unsure of door stops. Interestingly, the pattern associated with exact stops and cross queues sometimes impedes movement along platforms more than the elliptical crowding pattern, especially in restricted areas of platform (along sides of stairs or escalator wells). In regard to the study's observations, it was stated:

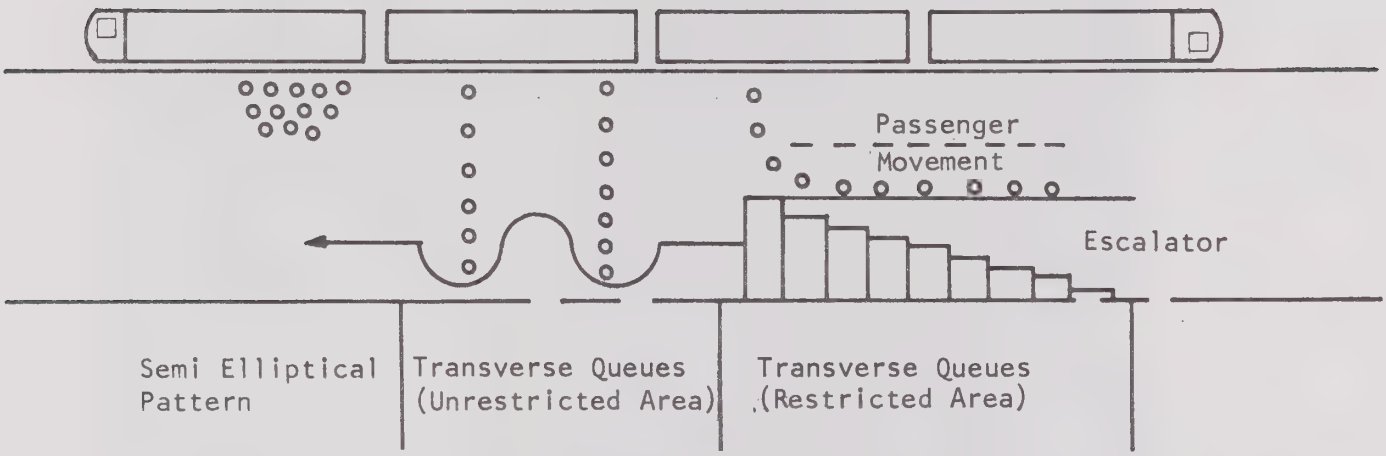
> When vehicles stop at the same place time after time, pedestrians have been observed to queue in well ordered lines, two abreast perpendicular to the length of the platform. These lines then tend to wind around following the rear of the platform and tend to interfere with the on-loading traffic. The semi-elliptical queue at the front of the platform appears to be the more common. In this case, loading takes place at the front of the platform, and cross traffic occurs at the rear (Figure 4.1).

When will the train come?

BART trains run on computer-controlled headways (intervals between trains) rather than on time schedules. However, service is often unreliable, and train delay is one of the major complaints patrons have about the system.

In a recent review of transit patron attitude studies, it was concluded that travel time reliability is an even more important factor to patrons

Figure 4.1
OBSERVED VARIATIONS IN QUEUE PATTERNS DURING PEAK PERIODS




than the total elapsed travel time.[1] This study's limited interviews with BART patrons also found reliability to be a major concern. BART's biggest problem since the inception of service has been low equipment reliability, which affects both the level and quality of service. Problems occur primarily among transit vehicles, in which high rates of component failure cause reductions in speed, thereby slowing system operations. In addition, the California Public Utilities Commission (CPUC) has placed restrictions on BART's operation, requiring trains to be separated by a distance of at least one station until the Train Control System meets PUC safety requirements.[2] Progress is being made in improving the control system.

The original plan called for two- to five-minute intervals between trains. The combined result of CPUC restrictions and limited car availability has been that train frequencies have been low even during peak periods. Trains are currently scheduled to run every 12 minutes[3] during the day and every 20 minutes at night. These headways are often further increased by equipment failures, although equipment performance is improving. Equipment failures tend to affect the entire system's operation even when a single train is involved, because of the headway tolerances required and because the automatic train control system treats the entire BART operation as a single unit.

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[1] Wachs, M. "Consumer Attitudes Towards Transit Service." op. cit.

[2] Some of the technical problems of equipment reliability are mentioned only briefly here as background information, since this study is concerned primarily with what the traveler experiences. Readers wanting more detailed technical information regarding equipment, reliability and maintenance should refer to Peat, Marwick, Mitchell and Co., Transportation and Travel Impacts of BART: Interim Service Findings, DOT-BIP-FR 6-3-75, Berkeley, California: Metropolitan Transportation Commission, 1975.

[3] Six minutes at downtown San Francisco and Oakland stations where the Concord and Fremont lines merge onto a single track. This six-minute headway will be reduced still further when direct service to San Francisco from the Richmond line is added in 1978.

Certain weather conditions also have an adverse effect on the frequency and reliability of BART operations. Rain or frost on the rails necessitates that trains be operated on "impeded mode," which is 70 percent of normal speed -- a 10 to 15 MPH reduction.[1] (This represents about a three minute increase in trip time between Concord and Daly City.) If normal speeds are attempted under these conditions, trains have been found to slide unexpectedly and overrun the stations. During unusually hot weather, signal boxes along the wayside have also malfunctioned and indicated the presence of "ghost" trains (i.e., false occupancy signals). Systemwide delays sometimes result because, in order to maintain required headways, other trains on the line cannot proceed until the safety of the track is confirmed.

Since January 1977, BART officials have been plotting percentages of headways at selected stations which exceed target headways by 50 percent. In addition, BART is just beginning a program to compare actual train run times with target run times for another measure of reliability.

Table 4.1 shows the percentage of headways exceeding target headways by 50% for the months of January through May 1977. Date are shown for five stations, each associated with a different BART line. Assuming that these stations are generally representative of their lines, the Daly City line to Embarcadero Station has generally the best reliability while the 19th Street area has the poorest, of the lines with 6 minute target headways. Among the lines with 12 minute target headways, the Richmond line has generally better reliability than the Concord line. As of June 1977, BART has set a goal for June 1978 to have a 25 percent on-time performance improvement. This means that it is desired to reduce the percentages of headways exceeding target headways by 50 percent to a systemwide average of 6.86 percent for any one month. Figure 4.2 shows a comparison of actual on time performance to the proposed goal.

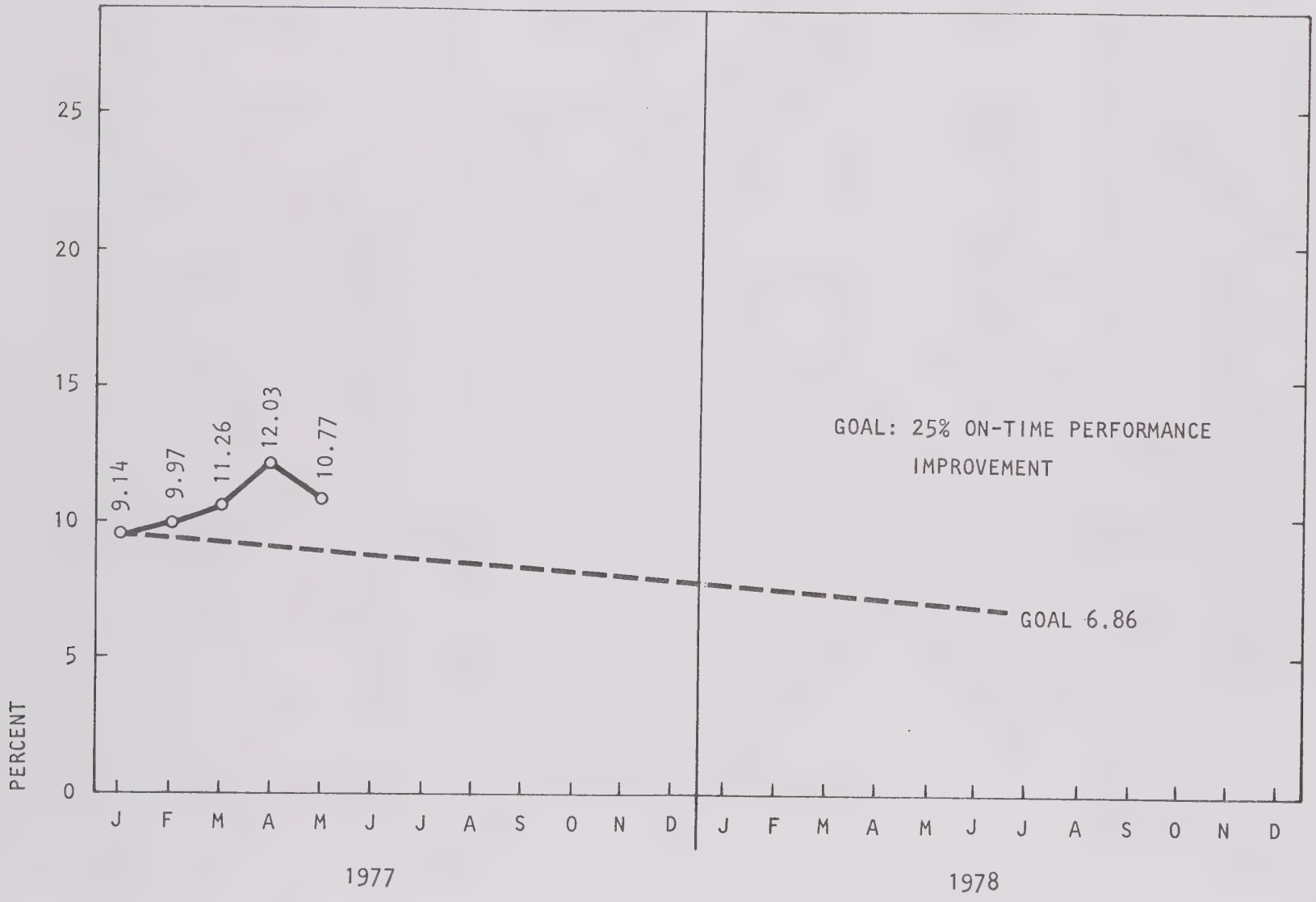
Table 4.1
PERCENTAGE OF HEADWAYS EXCEEDING
TARGET HEADWAYS BY 50%
(January - May 1977)

| Selected Station | Target Headway | Monthly Percentage of Headways Exceeding Target by 50% | | | | |
|---|---|---|---|---|---|---|
| | | Jan. | Feb. | Mar. | Apr. | May |
| Hayward | 6 minutes | 10.51 | 11.45 | 12.70 | 13.61 | 12.79 |
| 19th Street | 6 minutes | 11.81 | 12.57 | 13.49 | 14.83 | 13.16 |
| Montgomery | 6 minutes | 8.69 | 9.46 | 11.27 | 12.06 | 10.77 |
| Walnut Creek | 12 minutes | 6.59 | 6.65 | 8.88 | 7.74 | 7.08 |
| Berkeley | 12 minutes | 5.84 | 6.16 | 6.51 | 7.54 | 5.74 |

Source: Train Control Computer Headway Report for 5 Stations, BART Technical Services, June 1977

[1] A similarly adverse effect is created when excessive oil from the vehicles remains on the tracks.

FIGURE 4.2
PERCENTAGE OF HEADWAYS AT FIVE KEY STATIONS (HAYWARD, 19TH ST, BERKELEY, WALNUT CREEK, MONTGOMERY ST) EXCEEDING TARGET BY 50%




SOURCE: HEADWAYS SUMMARY REPORT, BART TECHNICAL SERVICES

Is there frequent communication regarding the current status of BART operations which affect the patrons?

Although BART has a sophisticated systemwide communication set-up, there are certain limitations at present which obstruct the rapid transmission of accurate information to the traveler. BART has the capabilities for communicating with the patron through announcements anywhere inside the station or via visual display on the Train Destination Signs (TDS).[1] Public address system announcements can be generated by the station or train attendants. TDS displays are activated by "canned" message displays or by messages generated at the time of an unexpected occurrence. In addition, the traveler can communicate with system personnel by use of intercom phone system within the stations and on the trains.

Despite this capability, one of the biggest complaints BART receives is that frequent delays and breakdowns are not communicated to the patrons, thus preventing them from informing associates of expected delays or to choose other modes of transportation. About 30 percent of the BART patrons surveyed commented on this problem.

In response to this need, BART officials have recently implemented or are in the process of implementing the following major improvements:

- Additional information from the train control computer. Software (computer program) changes are being made to provide specific passenger-oriented information (i.e., train locations, delay durations, etc.) which cannot be determined by observation.

- Additional and more efficient use of personnel and equipment. This includes:

  -- Additional personnel, (Passenger Communication Specialist), is being provided at Central to work full time airing public address announcements and operating TDS displays, thus freeing the Support Facilities Controller from additional task of coordinating passenger communications.

  -- Rewriting recorded messages and public address announcements for airing by train operators and station agents.

[1]As already mentioned, the primary purpose of TDS is to indicate the final destination of the next train approaching the platform. However their versatility allows them to be used for many other communications including advertisements.

-- Providing all stations with portable bulletin dispensers to make written communications to patrons available when necessary.

-- Providing station agents with more complete information of what is happening in operations. Closed circuit television monitoring of stations has been increased. At two stations, Rockridge and Ashby, there is an experiment to operate without station agents. There is remote communication between Central and the stations, and more monitored cameras than at other stations.

One needed communications improvement which has not been implemented is extension of public address speakers to the ends of platforms. At present, speakers are located only in covered portions of outdoor platforms and announcements are inaudible at various locations on the platform.

## SAFETY AND SECURITY

### Are patrons on the platforms safe from accidents?

In general, the typical platform is a safe place. However, some patrons, particularly the handicapped, are concerned about the possibility of falling off platform edges onto the tracks, especially when platforms are crowded. Actual accident levels on platforms are low: a total of only 24 occurred during the three month period of February through April 1976 -- 19 of which were falls on the platform; none were falls onto the track. Since BART operations began, only a very small number of falls onto the tracks have been reported. No serious injuries have resulted. Because, in fact, there are no barriers to prevent people from falling or jumping onto the tracks, several station agents interviewed said their greatest fear was the possibility of such an accident occurring, especially during crowded periods or at times when platform areas were not displayed on the TV monitors.

Originally, BART station design standards included transparent train screens at platform edges to shield patrons from trackway hazards as well as noise and wind. However, the concept was abandoned when it was determined that the point at which the train stopped could not be precisely predicted to match train and screen door locations.[1] As a partial

[1]McCutchen, W.R., "Passenger Design Standards for BART Stations." Proceedings from the ASCE Man/Transportation Interface Joint Speciality Conference, Washington, D.C. (Spring 1972), p. 101.

compensation, stations were required to have contrasting two-foot-wide warning strips on all platform edges. The effectiveness of these markings in alerting patrons to platform edges varies from station to station. Several variations are shown in Photos 4.4, 4.5 and 4.6. The most effective platform edges have the following qualities:

- Arrows which indicate the train door locations.
- Colors which contrast strongly with the platform surface.
- Textures which are distinctly rougher than the rest of the platform (especially if a non-slip material is used).

The textural differentiation is particularly important to blind and near-blind patrons who must rely on non-visual cues to orient themselves.

Are the platforms free from crime?

There is very little crime on the platforms. From February through April 1976, the most recent period for which data were available, only eight offenses were reported, four of which were for drunkenness. BART police officials stated that there are no design features in stations which they believe to contribute to crime. In general, the platform areas are open and visible, have good lighting, are monitored by TV cameras and have courtesy telephones enabling patrons to communicate with station agents.

## ENJOYMENT

What is the patron's visual impression of the platform?

In general, the platforms are simple and tastefully designed, affording the passenger a satisfying visual environment before boarding or after leaving the train (Photos 4.7 and 4.8). Station platforms are generally austere and businesslike. Their main features include the long, narrow configuration of the platform itself, vertical circulation elements (stairs, escalators and the elevator), and for above-ground stations, the canopy covering the central portion of the platform. Within the constraints of function, costs and ease of maintenance, architects expressed individual style through the use of different wall, ceiling and floor materials, the presence or absence of color and indirect or direct lighting schemes.

## COMFORT AND HEALTH

Are patrons protected from the weather while waiting on the platforms?

In above-ground stations a partial roof covers the central third of the platform for protection from sun and rain. Recently, glass enclosures were added to protect patrons from wind.

PHOTO 4.5

PLATFORM EDGE
MARKING
(MAC ARTHUR)

PHOTO 4.6

PLATFORM EDGE
MARKING
(LAFAYETTE)

For all above-ground stations, "a canopy or roof was to be provided over the four-car station core, projecting sufficiently to protect the platform from rain and sun, with provisions for its extension in the future." (Manual, Sec. 1.13). The station designers were given latitude as to the form and extent (beyond the required four-car length) of these canopies. Consequently, they provide one of the major design variations from station to station. The use of simple, utilitarian structural materials with some color seems to work the best for canopy design. (Photo 4.7).

The Bay Area in general has a temperate climate, although the combination of occasional low temperatures (30° - 40° F), fog, humidity or rain and strong winds (10 - 30 MPH) can produce unpleasant conditions. Many of the patrons surveyed complained about the lack of protection from the weather, especially the wind. Originally only four of the twenty above-ground stations had wind screens, but in the last year, several large glass enclosures have been installed at each of the remaining sixteen stations (Photo 4.8).

PHOTO 4.7

ABOVEGROUND STATION PLATFORM CANOPY (FRUITVALE)

PHOTO 4.8

WIND SCREEN ON STATION PLATFORM (RICHMOND)

Are the subway platforms well-ventilated?

The primary means of ventilation for the subway stations is via the piston action of the trains in the tunnels, forcing air through the entire station. This is the traditional method for subway station ventilation and the BART system proves that it continues to work quite well. Air velocity is noticeable on the platform, but less so than in other transit systems. (The BART range is between 660 - 1320 FPM in comparison to 2000 FPM recorded in the Toronto system.)[1] A secondary mechanical ventilation system, employing bi-directional fans, is provided to augment the primary system on exceptionally hot days, but the frequency of service failure has never reached the level at which the use of the backup system is required.

What sound levels are found on the platforms?

The sound exposure of patrons in stations is generated both by BART itself and by surrounding transportation sources. The sound levels in the stations are generally dominated by BART train-generated sound. Subway stations provide a substantial degree of acoustic isolation between the patrons and surrounding traffic, while most of the above-ground stations provide little isolation. Thus, only on the platforms of the freeway-median stations, such as Rockridge, MacArthur and Lafayette, is the sound level dominated by outside traffic sounds. At all of these stations, the plat-

[1]Associated Engineers. Subway Environmental Design Handbook, Volume I - Principles and Application. U.S. Department of Transportation, Washington, D.C. (1975), p. D-26.

form is only a few feet above the freeway, and no sound or visual barriers are provided. However, patrons interviewed made no complaints about such traffic sound.

BART train-generated sounds are greatest at specific end-of-the-line stations. A bead of weld material has been applied to the tops of the rails at three of the four terminal stations,[1] to increase the reliability of the train control signals which are transmitted along the rails. This application has significantly increased the train-generated sound levels in the station proper, as shown in Table 4.2.

$L_{eq}$ levels[2] recorded at nine stations representative of the system are summarized in Table 4.2.[3] Apart from the ends of lines, this table indicates that the sound due to BART train operations is relatively consistent from station to station of the same type.

Table 4.2
SOUND LEVELS AT STATION PLATFORMS

| Station Type | $L_{eq}$ (Attributable to trains only) |
|---|---|
| At-grade | 62-68 db(A) |
| Aerial | 69-74 |
| Subway | 70-73 |
| End-of-line | 80-83 |

Source: Bolt, Beranek and Newman Inc.

Maximum sound levels in most BART stations meet the sound level goals set by the insitute for Rapid Transit (IRT).[4]

The sound levels at some, though not all, of the BART stations fall well within the IRT guidelines. BART subway platform ceilings and undersides have been acoustically treated and in Embarcadero Station, the sound absorptive treatment is more extensive. Consequently, the stations are generally observed to be quiet. However, the maximum levels for trains entering and leaving vary widely from station to station and cannot be attributed to any architectural feature. The condition of the tracks at specific stations is the most likely explanation for the observed variance

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[1]Weld material was not applied to the tracks at the Richmond station.
[2]$L_{eq}$ (the equivalent sound level) yields an average hourly sound intensity due to BART train pass-bys only.
[3]Appendix Table A.1 indicates sound levels recorded at nine representative stations.
[4]Guidelines and Principles for Design of Rapid Transit Facilities. Institute for Rapid Transit, Washington, D.C. May 1973.

## Is air pollution a significant hazard?

Concentrations of localized air pollution (carbon monoxide[1]) in and around the BART stations vary considerably and are influenced primarily by motor vehicle activity and meteorological factors. No BART stations are in locations which consistently experience the Bay Area's worst air pollution levels. In addition, because of the brief interval of exposure, the prospects of BART users being affected by harmful dosages of air pollution are extremely low.

In general, since the automobile is such a dominant factor in contributing emissions to the environment, a BART stations's proximity to vehicle activity is relavant. Stations such as Rockridge and Orinda, located in freeway medians, as well as stations with large parking lots, experience higher levels than subway stations and others with no parking lots. However, local meteorological factors probably determine the air quality conditions. Exact measurements are beyond the scope of this study; they are probably unjustified because of the near certainty that CO levels are harmless.

Results of CO measurements taken throughout the Bay Area in 1974[2] indicate that BART users arriving at stations and waiting for trains do not experience adverse air quality likely to result in harmful health effects. During the testing the one hour Environmental Protection Agency standard of 35 ppm (parts per million)[3] was not once exceeded. Further, BART patrons are likely to encounter even less exposure to air pollution than that shown in 1974 measurements; air pollution standards have resulted in overall reductions of auto pollution since the 1974 measurements.

Within a givin station, the exact locations of best and worst air quality cannot be specified. Particularly for the above-ground stations and all those nearest freeways, the parking lot, station entrance, concourse and platform are all likely to have about the same air quality conditions. Thus, the BART user's potential exposure to localized air pollution must include the time from station approach to train entry. During the peak commuter periods when the highest levels of carbon monoxide are likely to occur, the BART user's time in the station area seldom exceeds 15-20 minutes. This is far less than the one-hour exposure on which the 35 ppm standard is based.

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[1] CO is used as the indicator pollutant of the local impact of BART-related motor vehicle traffic for this study for two reasons. First, use of this indicator is an extension of the Environment Project's Phase I work, done by TRW. Second, CO is one air pollutant which can be clearly traced to motor vehicles.

[2] Bay Area Pollution Control District. Air Pollution and the San Francisco Bay Area. 10th edition, March 1976.

[3] U.S. Environmental Protection Agency, "Guidelines for Air Quality Maintenance, Planning and Analysis." Volume 9, Evaluating Indirect Sources. EPA-450/4-75-001. January 1975.

What amenities are provided on the platform?

Few amenities are provided on the platform, based on the original premise that patrons would be in the station for only a short time. There is seating on the platforms, but in general it was observed to be designed for durability rather than comfort and for only small numbers of people (Photos 4.9 and 4.10). One-third of the peak hour patrons surveyed commented on the inadequate seating on the platform. Recently, several wooden parkbench-type seats have been added to the platforms of each of the above-ground stations, inside the new wind protection enclosures. However, the subway platforms typically have uncomfortable masonry benches, with a capacity for only a few persons.

Telephones are provided on a few, but not all, platforms. Both station agents and patrons surveyed commented that telephones should be placed on all platforms, to allow riders to contact families or others expecting them when the trains are delayed. At present, patrons must in most cases leave the platform and possibly miss the next train in order to call. The TDS signs are also used to display time on a periodic basis, brief news announcements, and advertising messages. Clocks on the platform are provided only in the newest station, Embarcadero.

PHOTO 4.9

SEATING ON
SUBWAY PLATFORM
(EMBARCADERO)

PHOTO 4.10

SEATING ON
ABOVE GROUND
PLATFORM
(FRUITVALE)

CHAPTER FIVE

## ON THE BART TRAIN

### GENERAL CHARACTERISTICS

In 1963, PBTB recommended a steel-wheel/steel rail train design.[1] Other alternatives evaluated included various suspended, monorail and dual rail designs with rubber tires as well as the more conventional steel wheels. PBTB's conclusion was that the recommended design offered the best combination of safety, speed, capacity, operating efficiency, quietness, comfort and flexibility. In addition, it appeared to be relatively cheap while meeting basic engineering requirements.

After several years of design and development, a construction contract was awarded in 1969 to build 450 cars. Basic specifications for the vehicles are shown in Appendix C.3.

The BART trains were designed to be modern in appearance (Photo 5.1) with a simple but luxurious carpeted interior that minimizes maintenance needs (Photo 5.2). There is a continuous aisle along the length of the train, enabling passengers to move from car to car when the train is in motion. Seats are cantilevered from the side walls, arranged in a two by two fixed configuration. Each car can seat 72 people.

Vehicles are air conditioned and sound-insulated with large laminated windows. There are doorways on each side of each car; those on the side facing the platform open and close automatically at each station unless controlled by a train attendant.

BART trains consist of two basic vehicle types (A and B cars). The configuration is identical in all respects for both vehicles except that an "A" car has an attendant cab mounted in front (Figure 5.1). A train ready for operation consists of a minimum of two "A" cars which are coupled back-to-back. Passenger capacity can be increased by coupling from one to eight "B" cars between the two "A" cars.

The cars are made of aluminum and are relatively lightweight compared with other rail systems. The system will accelerate the trains from a standstill to 50 MPH in 20 seconds and decelerate them from 80 MPH top speed to a stop in about 27 seconds. Average acceleration is 3.0 MPH/sec.

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[1]Parsons Brinckerhoff-Tudor-Bechtel. Transit Vehicle System Evaluation and Recommendations. San Francisco, 1963.

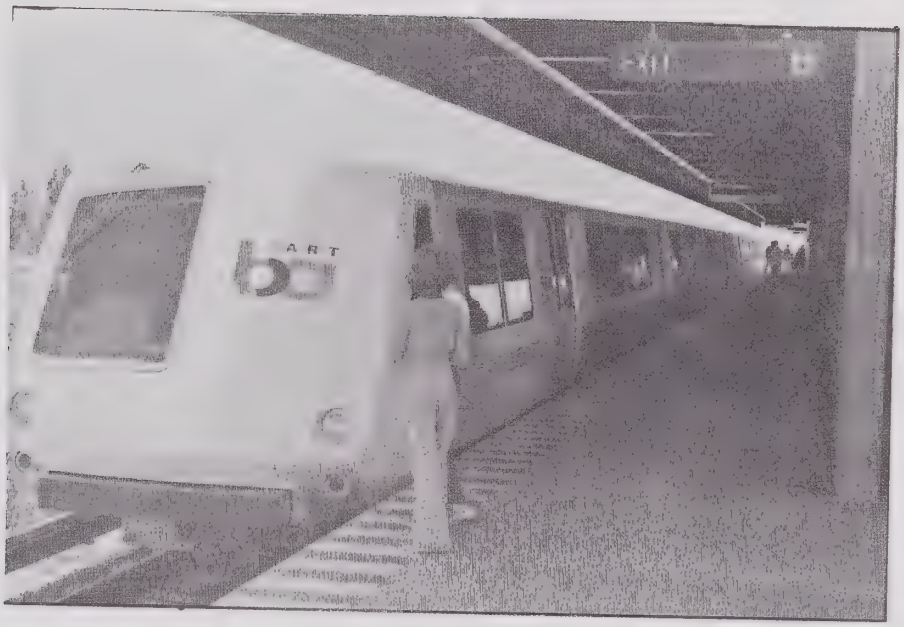


PHOTO 5.1

BART VEHICLE
EXTERIOR
(3/4 VIEW FROM FRONT)

PHOTO 5.2

BART VEHICLE
INTERIOR

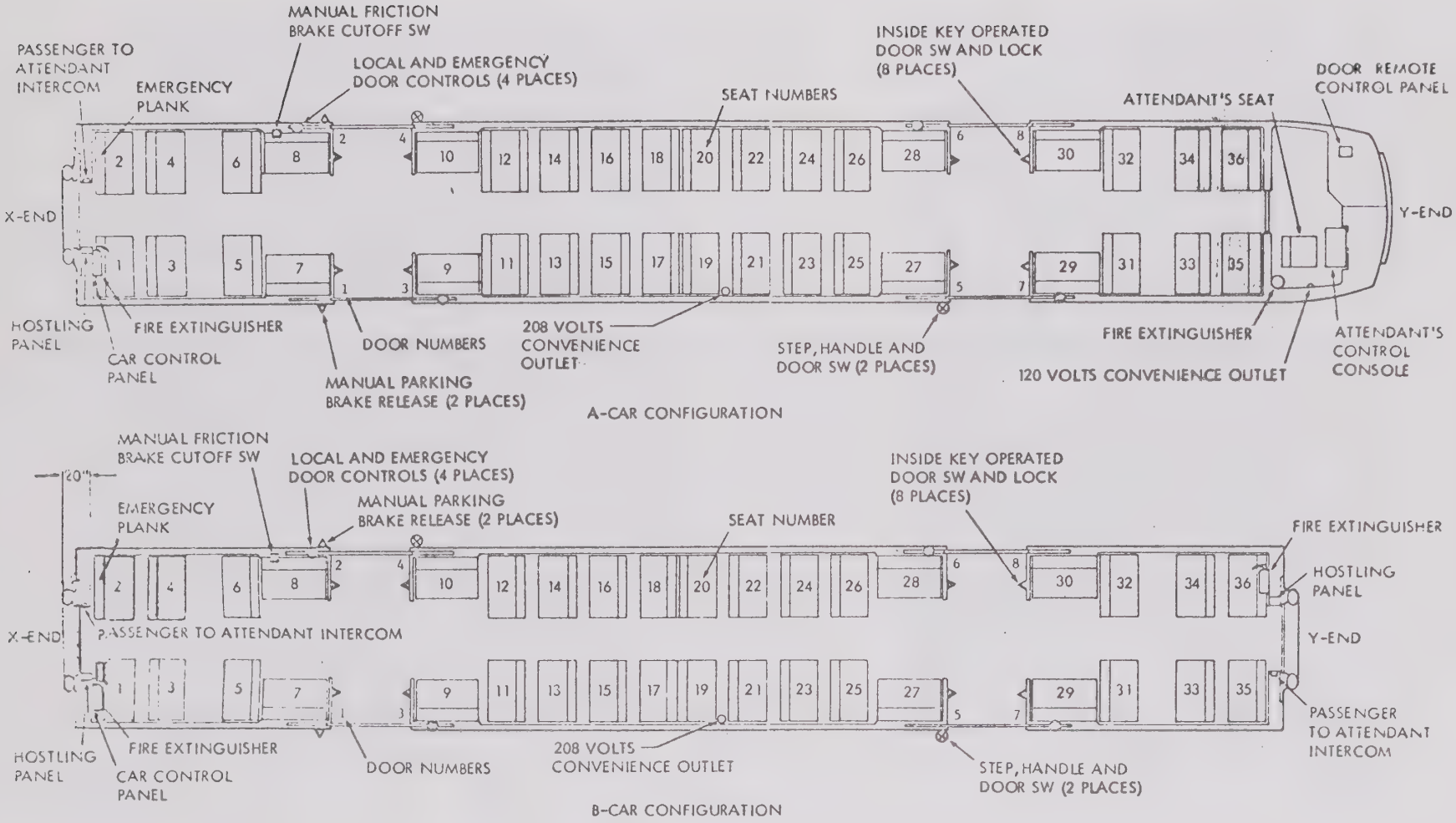


Figure 5.1
THE BART VEHICLE

Source: Applications of BART PROGRAM EXPERIENCE TO THE UMTA URBAN RAPID RAIL VEHICLE & SYSTEMS PROGRAM. Prepared for DOT by Boeing Vertol Company Philadelphia (April, 1973)

## DESIGN AND LAYOUT

### How does a rider enter the train?

BART trains are designed to stop so that their doors align with the same platform location each time. Train doors operate automatically, and stay open for 15 - 30 seconds[1] unless controlled manually by a train attendant. During peak period conditions, travelers form lines to enter and exit in a reasonably orderly way. However, the formation of these lines sometimes impedes movement onto platforms from escalators and stairs.

### Are there enough seats?

Seat availability is one of two amenities (the other being air conditioning) considered most important to riders on transit systems.[2] Train seating is comfortable and readily available except during rush periods. Each car seats 72 patrons but during peak periods twice that number may ride standing up. This crowding is typical of rapid transit systems oriented to serve the commuter.

### If there isn't seating, can a patron stand safely?

During rush periods an additional 150 people or so are sometimes crowded into BART cars, and until recently the only handholds were small grips on the backs of aisle seats (26 per car). (Photo 5.3) The ability to maintain one's balance without a handhold is not always possible. It varies with train speed and track section. Recently, overhead handrails have been installed on all cars, but they run only the length of the seating, and none are provided in the vestibules inside the doors (Photo 5.4). BART personnel stated that this omission was made for safety reasons (so people woundn't bump their heads) and to encourage movement into the car away from the doors. However, enough people travel during peak periods to crowd both the aisles and the vestibules. Thus, people frequently must stand in the vestibules without the aid of handholds.

Because the newly-installed handrails were placed very close to the ceiling (actually as high as the car doorways), it is difficult for persons under 5'2" to reach them. Comparative heights are shown below:

| | |
|---|---|
| Door height | 6'3" |
| Handrail (car middle) | 6'4" |
| Handrail (car end) | 6'3" |

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[1]An exception is the MacArthur Station, where dwell times are 105 seconds for outbound trains, so transfer connections can be made.

[2]Wachs, op. cit.

PHOTO 5.3

VEHICLE SEAT
BACK HANDHOLDS

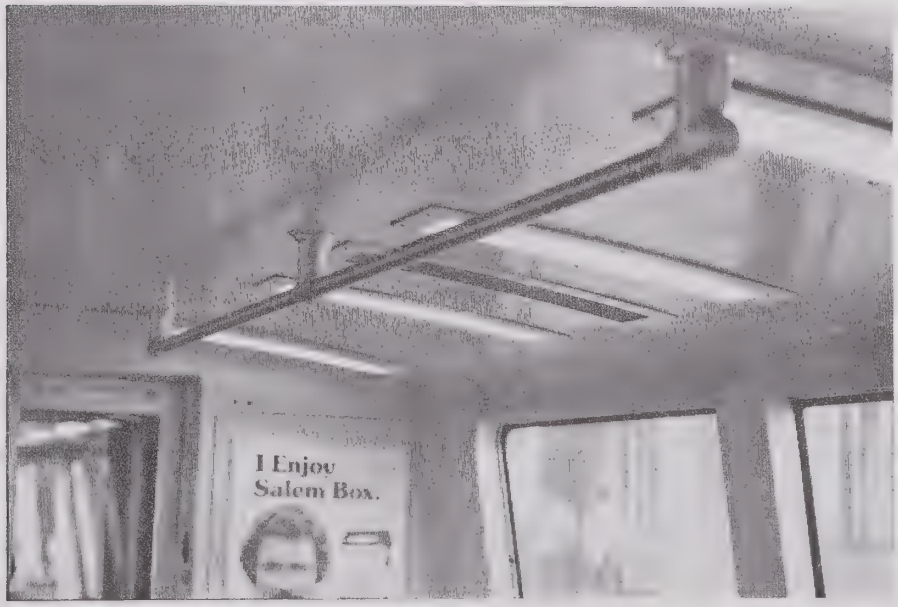


PHOTO 5.4

VEHICLE OVERHEAD
HANDRAILS

Are aisles sufficiently wide?

When the aisles are crowded during peak periods, it was observed that passengers found it difficult to exit if they were not near a door. Originally, the 30" width of the aisle was designed so it "...would also suffice for subsequent narrower 3 and 2 seating and a narrow aisle, should demand ever exceed design capacity in the future."[1] However, that modification is pointless since the number of additional seats would not be sufficient to accommodate everyone, and the narrow aisles would be an even greater obstruction to movement, during crowded rush hour conditions.

Strollers, carriages, bicycles, wheelchairs and other large items must be accommodated in the vestibules and at the adjacent center facing seats where there is an additional 22" of aisle width. Placing these objects in the aisles creates obstructions to movement.

Is it easy to move between cars?

There is a continuous aisle along the full length of the train permitting passenger movement from car to car when the train is in motion.[2] However, the doors between cars are difficult to open, especially when a patron is carrying something. Originally, the doors were to be passenger-operated by treadles or pushbuttons,[3] but they were replaced by hand-operated spring-loaded design. The springs are heavy (in order to keep them closed and free from rattles), making the doors difficult to open and discouraging movement between cars. Simple sliding doors (such as those used in New York City subways) or pneumatically-operated doors (such as those used on many rail lines) are much easier to operate.

COMFORT

Are the seats comfortable and roomy, and is there space for packages?

Seating is generally comfortable with few exceptions, and there is some luggage/package space underneath seats due to the cantilever design. The padded seats are quite comfortable and spacious (Photo 5.5). Seats are 44" wide, allowing a 22" width per passenger with 12" between seats (front and back) for leg room. Seats facing each other are 22" apart and also comfortable. However, when transverse seats are adjacent to aisle-facing seats (Figure 5.1), there is only 8" of leg room between them. This was observed to be inadequate for tall people (Photo 5.6).

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[1]Lawson, K. L., "Development of the SFBART Vehicle," paper presented at the National Transportation Symposium, San Francisco, May 1966, p. 3.

[2]Unlike the new transit system in Washington, D.C. which allows such movement only between "married pairs" of cars.

[3]Conway, P. L., "The BART Design Car -- How It Began," Sundberg-Ferar, Minneapolis, October 1966, p. 4.

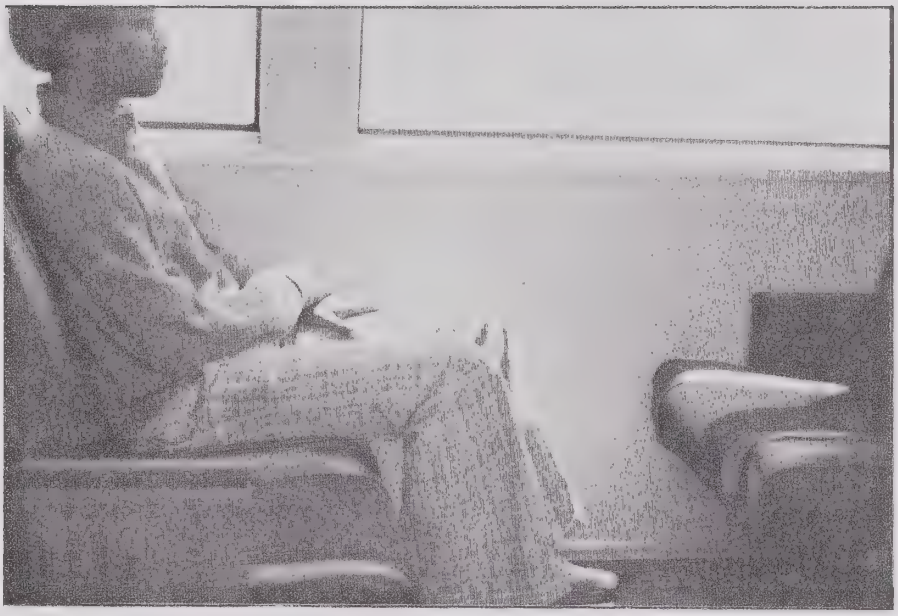

PHOTO 5.5

TYPICAL
SPACIOUS
SEAT

PHOTO 5.6

SEATS WITH
INADEQUATE
LEG ROOM

The seats are arranged in a fixed configuration with half of the seats facing forward and the other half facing backward. Observation indicated that people almost always choose forward-facing seats first. Patrons surveyed, although generally positive on the comfort of the seating, sometimes commented negatively on the backward-facing seats. Adjustable forward/backward-facing seats, as found in many modern commuter rail vehicles, enable patrons to rearrange them for specific social activities.

Because of the cantilever seat design, there is a 9" clearance under all seats, permitting easy, out-of-the-way placement of medium-size suitcases or any packages less than 9-inches in width. However, larger items could become obstacles, especially during crowded conditions.

Is the ride quality good?

BART's ride quality is generally excellent and probably equal or superior to any other rapid transit system in North America. When asked to mention particularly good features of BART trains, panel survey respondents most often cited ride comfort.

One of the sources of comfort is a generally low level of vibration with little sway. BART cars are supported on eight air-cushion bellows which absorb more vibration than mechanical springs. With the continuously welded track, this creates a very smooth ride. It was observed that reading and napping can be done easily.

Wilson et al[1] have reported vibration levels measured at several positions in BART vehicles. These date indicate that the vibration specifications established for the BART vehicles (0.01 in/sec rms for frequencies below 10 Hz and 0.03 in/sec rms for frequencies above 10 Hz) have not been achieved. However, this is apparently not a problem; figure 5.2 graphically illustrates measured vibration levels along with the BART vehicle specifications and an indication of the subjective evaluation of vibrations of various levels and frequencies. Of note is the fact that, while the measured BART vehicle vibration levels tend to fall in the "Strongly Noticeable" category, they do not pass into the "Unpleasant" region.

In the Transbay Tube, trains stop occasionally and then accelerate to a cruising speed as high as 80 MPH. Although BART officials stated that acceleration is no greater than anywhere else on the system (3 MPH/sec), on several occasions the effect on the riders was observed to be unsettling, most likely because of the higher noise levels in the enclosed concrete Tube. BART has recently increased the use of a 70 MPH cruising speed and restricted its 80 MPH operations, which may improve this situation.

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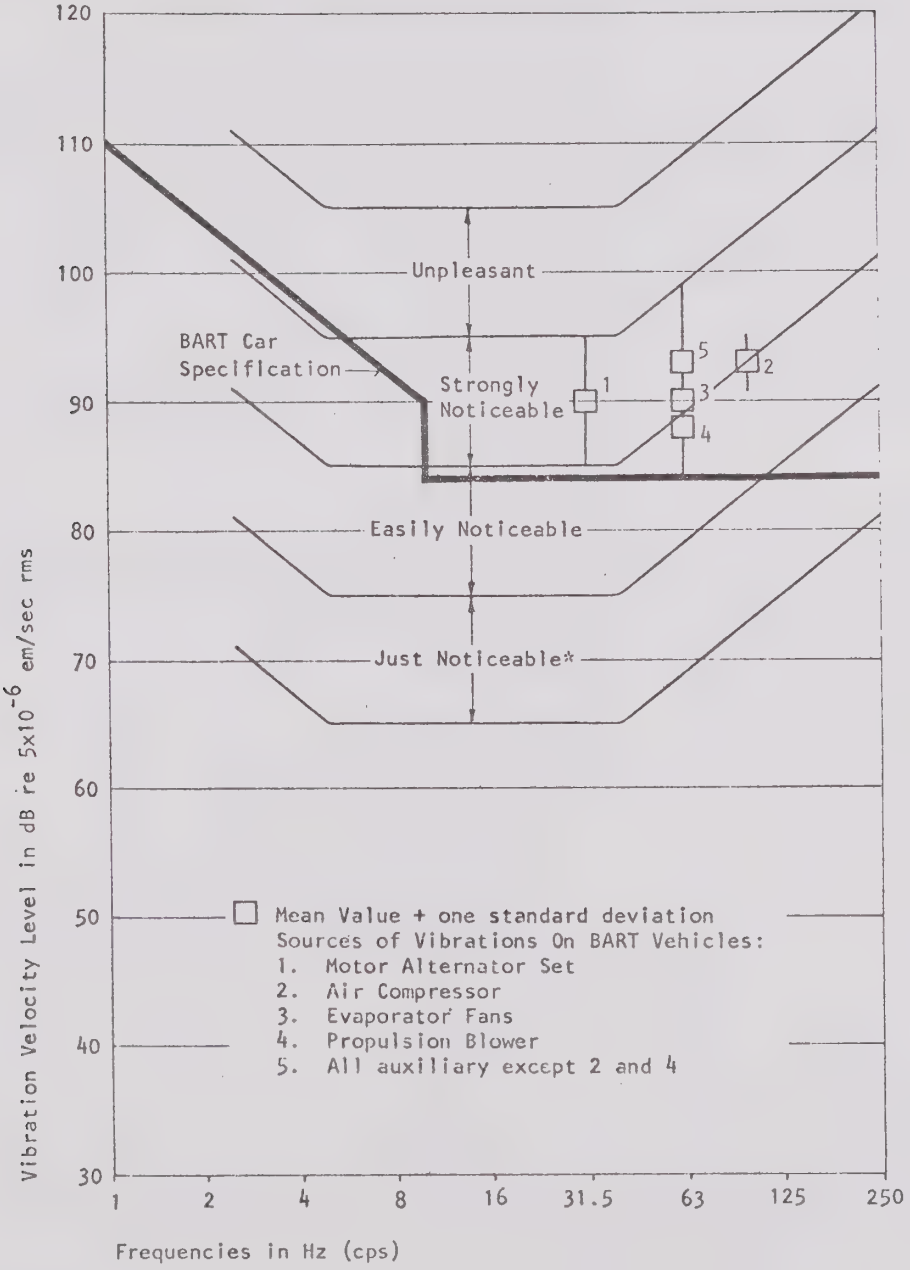
[1]Wilson-Ihrig & Associates. "Transbay Tube Pressure Transient Measurement." Letter report to SFBARTD, January 1975.

Figure 5.2
VIBRATION LEVELS AND THEIR POTENTIAL EFFECTS ON PEOPLE [1]




[1] Wolfe, S. L. et al. Assessment of Urban Rail Noise Climates and Abatement Options Noise Assessment Report. Volume 1, BARTD Report #DOT-TSC-850-2, March 1976.

What about sound levels aboard BART trains?

Maximum measured sound levels in the trains are generally higher than those measured on platforms, and the strict IRT design goals are not achieved inside the trains (see Table 5.1). However, few patrons seem to notice train sound levels. In comparison with other transit systems, the noise levels on BART trains are either about the same or lower.[1]

The sound levels on board the BART vehicle vary with train speed and track configuration. Sound level recordings were conducted on board BART vehicles during two complete end-to-end traverses of the BART system, and the mean $L_{eq}$ for all the trips was 76-77 dB(A).[2] Tie-and-ballast track configuration was found to create the lowest level of sound on board the vehicle, followed by track on aerial structures and in subways. In general, the differences in the maximum sound levels observed on aerial structures are some 4-5 dB higher than on tie-and-ballast track. The maximum sound level in subways is 0-13 dB higher than on open tie-and-ballast track. A few short subway segments contain tight turns or other track configurations which lead to a noticeable, but not severe, amount of wheel squeal. Most of this is effectively masked by the car's insulation, fixed windows, and tight door seals.

No attempt was made to quantify differences in sound levels for various positions within a car. However, previously recorded data[3] indicates that a 4 to 5 dB difference is found between the loudest locations (over train wheels) and the quietest locations (near the center of the car). This amounts to a just-noticeable difference.

Table 5.1
COMPARISON OF SOUND LEVELS IN BART TRAIN INTERIORS AND IRT DESIGN GOALS

| Item | IRT Design Goal Max db(A) | Observed BART Range Max db(A) |
|---|---|---|
| Tie-and-Ballast Track Bed - maximum speed | 68 db(A) | 76 - 79 db(A) |
| Open Concrete Track Bed - maximum speed | 72 db(A) | 81 - 84 db(A) |
| Subways - maximum speed | 78 db(A) | 89 - 92 db(A) |

Source: Bolt, Beranek and Newman Inc.

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[1] De Leuw, Cather & Company. Comparative Analysis Study of Alternative Transit Systems, South Hills Corridor. Port Authority of Alleghany County, Pennsylvania, 1976.

[2] Appendix Table 7.2 gives the $L_{eq}$ and $L_{max}$ for all trip segments.

[3] Dieckmann, D. "A Study of the Influence of Vibration on Man." Ergonomics 1 (1957).

Are travelers subject to any discomfort due to air pressure and temperature changes?

The train air-handling systems are adequate for the maintenance of passenger comfort under all but extreme conditions, and the system is quite reliable. A dependable temperature control system is one of the most important amenities for patrons on transit systems.[1] Each car on BART is equipped with a 12-ton capacity air-conditioning system. The air-conditioning handling system is designed to furnish 3,000 cfm of air in the car with not less than 800 cfm of fresh air being introduced. The intended car temperature range with 72 passengers in the car is 72 - 77°, 60 percent relative humidity within the car. For the most part, temperatures and air freshness on the BART trains remain well within intended limits.

Although BART experienced a series of difficulties with the refrigeration compressors which adversely affected the reliability of the car air-handling system, this problem seems to have been solved.

The sudden change of car air pressure as BART vehicles enter and exit tunnels and as they pass by vent shafts and other openings in the tunnels has been an area of significant concern to BART. Several studies by Wilson[2] and others[3] have indicated that the magnitude and rate of these air pressure changes exceed recently suggested IRT criteria for all avoidance of passenger discomfort. The areas where these pressure changes seem to be worst is in the Berkeley Hills tunnel and in the Transbay tube. Although the pressure changes exceed the criteria that have been suggested, the excesses are marginal causing no significant problems and few complaints from patrons.

What about air pollution in the trains?

Although measurements of air pollution levels within the BART train are not available, several factors would suggest that air pollution levels are even lower than these experienced in stations areas:

- The train has an internal ventilation and air-conditioning system.
- The train's external environment is moving and not in a localized "hot spot" (i.e., a center of pollutant-producing activity).
- The moving train itself creates turbulence and thereby disperses gaseous pollutants.

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[1]Wachs, op cit.
[2]Wilson, Ihrig & Associates, op. cit.
[3]Parsons-Brinckerhoff, Quade & Douglas. Aerodynamic and Thermodynamic Validation Tests in Berkeley Tunnel. Report #UMTA-DC-06-0010-73-1. Prepared for the Urban Mass Transportation Administration.

Is the lighting system adequate for patrons' needs?

The lighting system is an excellent synthesis of natural and artificial lighting. The basic design considerations were to provide lighting intensity sufficient for comfortable reading without subjecting passengers to direct glare, and to minimize contrast between natural and artificial light when entering and leaving subway stations.[1] In daylight, the 1/4" tinted glass windows provide excellent exterior visibility and glarefree interior illumination. The contrast between daylight and subway illumination was observed to be barely noticeable, while reading and interior lighting met the design recommendations described above. However, it was observed that the wall lights spaced along the Transbay tube, where trains are traveling at high speed, produce an annoying "flashing" effect. BART officials stated that the lighting is necessary to illuminate the tunnel for maintenance and safety reasons, even though it may have a hypnotic effect on the driver.

ORIENTATION

Are there informational aids on board trains?

There are four large systems maps in each car centrally located on the wall behind the seats near each door (Photo 5.7).

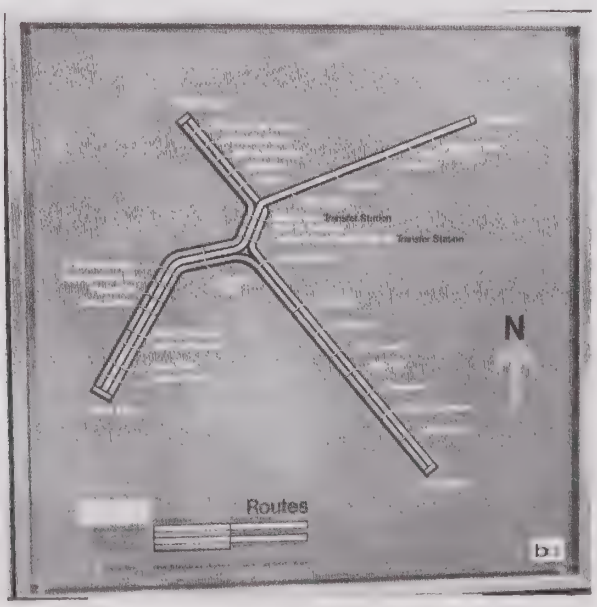


PHOTO 5.7

SYSTEM MAP
ON BOARD
BART TRAINS

[1]Lawson, op. cit., p. 6 furnishes a more technical description of the lighting system design. For additional details see Conway, op cit., p. 9.

PHOTO 5.8

ADVERTISING DISPLAY ON TRAIN

What about train exteriors?

The BART train embodies contemporary industrial design in a modern sleek vehicle. Even though some BART architects feel the vehicle could become prematurely obsolete because the design is not an enduring one, it is apparent that those cars which have been kept clean and in good repair are, in fact, quite durable. In order to maintain the appearance of the BART train exterior, the three yards (at Concord, Richmond, and Hayward) have installed automatic car-washing equipment.

Is the view from the train interesting and easy to see?

One of the primary enjoyments of riding on BART is taking in the panoramic view of the surrounding terrain when the train is traveling the 51 miles of above-ground trackway. Consequently, BART has become a tourist attraction not only for the chance to "experience" the system, but also as an economical way to see the area. Round-trip excursion fares of $1.00 permit three hours of unlimited travel from any station as long as patrons exit only at the same station they enter.

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[1]"BART Cars." BART Public Information Office, Oakland, February 1976.

How are patrons informed of their arrival at their destination?

As the train arrives at each station, patrons are informed of their location by station designation signs on the platform, general landmarks and announcements on the train's public address system. Large windows make it easy to identify each station from the train. Also, when trains are traveling on above-ground trackways, travelers can orient themselves by landmarks if they are familiar with the area. Arrival announcements can be made by the driver through the train's public address system. However, there is considerable variation in the clarity and audibility of the message. This variation can be caused by a combination of P/A systems malfunctions[1] and/or inconsistencies in the train attendants' use of the system (i.e., not making announcements or making them when ambient noise levels are high).

CONVENIENCE

Will the BART traveler need to transfer to another train?

At present, BART trains run from Concord to Daly City, Fremont to Daly City, and Fremont to Richmond. There is as yet no direct service from Richmond to Daly City, and direct service from Richmond to Concord cannot be provided. Those making such trips must transfer at one of the central Oakland stations which are clearly indicated on all BART maps. Virtually all transfers are made without leaving the platform. However, the delay, which is from five to 20 minutes, is a major source of inconvenience.

ENJOYMENT

Are the train interiors aesthetically pleasing and well-maintained?

Vehicle interiors were designed to attract commuters from using their automobiles by offering luxurious comfort[2] while still making the interior durable, simple, and easy to maintain. Eating and smoking are prohibited to encourage cleanliness as well as for fire prevention purposes. The cantilevered seats permit unobstructed sweeping and vacuuming of the carpeted floors. Also, there are 110 volt AC outlets in the car (as byproducts of auxiliary equipment) which permit the use of conventional items for maintenance (such as vacuum cleaners, rug shampooers and electric hand tools) without an outside source of power.[3] The seats are covered with a material which can be sealed by heat if slashed by vandals. Advertising is used in the cars through a limited number of custom-fitted placards (Photo 5.8).

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[1]"BART Cars," op. cit.
[2]Lawson, op. cit.
[3]Gregerman, E.M., "What's Different About BART Cars?" Paper presented at the ATA/IRT Conference, Boston, 20 April 1970, p. 4.

SAFETY/SECURITY

Is it safe to board and ride BART trains?

Of reported accidents fewer occur on the train than in the station, and most of them take place while patrons are boarding or alighting from the vehicle. Table 5.2 shows the distribution of accidents reported for various train-use activities.

Table 5.2
ACCIDENTS RELATED TO TRAIN USE
(February through April 1976)

| Activity | Accident Reports |
|---|---|
| Boarding | 11 |
| Alighting | 20 |
| Standing on Train | 7 |
| Sitting on Train | 1 |
| | 39 |

Most accidents in trains have occurred when persons have been standing in aisles or vestibules during the evening rush periods. Of the accidents shown, nine persons were caught in train doors and seven had accidents while crossing the gap between the platform and train. (Six of these were falls.) Almost all of the falls were contributed to by crowding or pushing. When the doors are not functioning properly, they can close unexpectedly; however, a safety mechanism prevents the train from starting while persons are caught in the door. The minimum opening that will keep the train from starting is fifteen and three-quarter inches.

Based on past record and design, it is highly unlikely that the train itself will be involved in an accident. To date, only one accident has resulted in patron injury. Rock throwing has caused some passengers to be injured by shattered window glass. According to BART police, this type of accident occurs most frequently on at-grade track near economically depressed areas and shcools. However, the frequency of rock-throwing has diminished significantly in the last year.

What are the chances of crime occurring?

Fewer crimes occur on a train than in a station or parking lot. Most of the reported offenses are related to drunkenness and vandalism (refer back to Chapter Two, Table 2.3) and are committed between 6 PM and midnight.

If an accident or crime occurs, what emergency equipment or help is available?

BART police are rarely present on the trains. Therefore, an emergency intercom is located at either end of each car through which the train operator can be contacted for assistance.[1] However, the existence of this equipment is not well publicized nor is its location in the vehicle clearly indicated.

Emergency door releases are located behind side seats near the side doors. Fire extinguishers and emergency planks for exiting are located at the rear of each car. Recently, stickers which indicate the location of fire extinguishers have been placed on the doors between cars.

[1]See Chapter Three, p. 42 for a complete discussion of the emergency intercom system.

# CHAPTER SIX

## LEAVING THE SYSTEM

Leaving a BART station after the train trip is not simply a reverse of the entry process. Exiting involves fare collection, finding the correct exit from the station, and connecting with other modes of transportation if necessary.

### LEAVING THE TRAIN

#### Is there enough time to get off?

Two sets of double doors on each side of the car accommodate relatively quick movement out of the vehicle. Train doors usually remain open for 15-30 seconds, depending on the degree of crowding. The operator controls the closing of the doors, which normally allows for orderly entry and exit. If a patron is unable to disembark and misses a desired stop, additional travel time is likely to be less than 15 minutes.

#### What if the patron doesn't get off at the intended stop?

It is easy for a patron to get off at the next stop and take a train back to the proper station without additional cost. This procedure usually takes fifteen minutes or less. However, depending on the time of day (especially evening) and the location on the system (since headways and travel times vary among stations), the additional travel time could be as much as 30 - 40 minutes even if trains are running without delay.

### THE STATION EXIT PROCEDURE

#### How does the patron get off the platform?

Patrons move from the platform to the fare collection areas in the concourse via stairs, escalators, or elevator (if necessary).[1] Exit signs leading to these areas are usually visible on the platforms, and these exits are typically so obvious as to cause no problems. Only in a few of the longer subway stations is there any indication on the platform of where each exit leads in relation to the streets above.

#### What is the procedure for getting through the fare gates?

In order to exit from the station, a patron must pass through the fare gates where tickets are processed to determine values and subtract charges.

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[1]See Chapter Seven for details on the elevators in BART stations.

If tickets are of insufficient value, a patron must use the "Addfare" machine to increase the value of the ticket.[1] The fare gates can delay a patron's exit from the station, especially during rush periods when the following conditions occur:

- There are not enough exit gates in operation. AFC equipment is unreliable and mechanical failures occur quite frequently. Peak hour patrons surveyed identified this situation as a problem, as did BART staff.

- Patrons favor certain sets of exit gates even though others are open. This appears to be due to their desire to minimize walking distance, even at the cost of waiting in line. It is particularly evident in the downtown San Francisco stations where most exiting patrons are headed north, even though only 20 - 30 steps are saved by using the north gates.

- Occasional users or visitors hesitate at the fare collection gates if they become confused about the procedure. This is especially evident at Powell Street, the station most frequently used by tourists.

- Lines form at the "Addfare" and change machines when many patrons at one time happen to have tickets of insufficient value. The "Addfare" machine will accept exact change only, necessitating the use of a separate change machine to complete the procedure and causing further delay. Peak hour patrons surveyed also commented on this.

- At particular stations (e.g., 12th Street-Oakland), the station layout is such that queues for the "Addfare" and change machines extend into the exit gate entry area, interfering with general patron movement. BART station agents surveyed commented on this occurrence.

Because of these conditions, the station agents position themselves in fare collection areas during heavy exit periods in order to instruct, advise and generally assist patrons in moving through the fare gates rapidly. As a result, problems are minimal in most stations. In some stations with heavy peak period use and large numbers of tourist travelers, however, the size and organization of the space itself will continue to cause delays.

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[1]See Chapter Three for a more complete discussion of the automatic fare collection (AFC) system.

LEAVING THE STATION

How does the patron find the proper street exit?

In above-ground stations, exits are usually obvious because of the relatively small size of the concourse. However, in a few of these stations and almost all of the subway stations, street destinations of exits are not obvious nor are they indicated by clear and frequent signing. This is especially true of the downtown subway stations with large concourses and several exits separated by considerable distances. Infrequent users commented on being confused as to which exit to take. Station agents confirmed that many patrons rely on them for directions to their desired exit.

Is it easy to find the right bus if a connection must be made?

At many stations it is difficult to find the correct connecting bus, although only for first-time or occasional users. Station agents interviewed stated that they are constantly asked about connecting bus service because the maps and signs do not seem to satisfy patrons' needs. Map brochures entitled "BART and Buses" (showing all connecting bus routes) are available from the station agents, but generally are not on display or advertised. Finding the bus stop itself can be a problem when buses stop outside BART parking lots and no signs in the lots indicate bus stop location. Generally, the bus stop signs (provided by the bus operating agencies) do not include route numbers or major destinations. However, BART has begun a program to improve bus stop signing.

What joint-fare transfer arrangements exist between BART and bus operators?

As described in Chapter Two, BART has discount transfer systems in operation with both Muni (San Francisco) and AC Transit (entire East Bay). Although the two systems differ, both are intended to provide 50 percent savings on round-trip bus connections to and from BART. Both employ transfer dispensers placed in the concourse just inside the fare gates.

Are patrons protected from the weather while waiting for a bus?

At almost all bus stops located away from the protection of the station entrances, open-air shelters have been installed which shield the patrons from the elements (Photos 6.1 and 6.2).

Is it safe for patrons to wait outside the station?

Few accidents or crimes have occurred in waiting areas outside stations.[1] The low crime rate may be due to the fact that pedestrian traffic crossing

[1]See Chapter Two for a more complete discussion of safety outside the BART station.

most plazas and exterior station areas is heavy during the day. In addition, many of these bus stops are visible to station agents. Exceptions are those stations at which the bus stops are some distance from station entrances (e.g., MacArthur, Oakland West).

PHOTO 6.1

OPEN AIR SHELTER
AT BUS STOP
(NORTH BERKELEY)

PHOTO 6.2

OPEN AIR BUS STOP
SHELTER UNDER COVER
(DALY CITY)

## CHAPTER SEVEN

## BART AND THE HANDICAPPED

Although elderly and physically handicapped people must cope with the BART system in much the same way as people without disabilities, their problems are accentuated in three main areas: accessibility to the system, orientation and barriers to movement. This chapter focuses on what is different about the handicapped patron's experience of the BART system. Special consideration will be given to the problem of mobility for those patrons with severe motor disabilities (e.g., wheelchair patrons), and the difficulty of orientation encountered by blind and near-blind patrons. These findings combine the evaluation of a study staff member who observed facilities for the handicapped throughout the system and a summary of two recent studies prepared by the Metropolitan Transportation Commission.[1,2]

### ARRIVAL AND ENTRY

#### How does the handicapped patron arrive at the BART station?

A majority of the semi-ambulatory persons who were surveyed was able to use buses and other forms of public transportation to arrive at a BART station. However, persons in wheelchairs are usually forced to use private transportation. None of the bus lines which serves BART are designed for level access by persons in wheelchairs.

#### What innovations and modifications of design and layout aid the handicapped?

Persons with mobility problems are especially provided for in the layout of parking lots and other station access areas. There are auto stalls reserved for the handicapped which are wider than usual and are located near station entranceways. All station access areas have ramps with a slope not exceeding 8.3 percent. The escalators connecting the various levels of the station are designed to move large numbers of people quickly (at a speed of approximately 120 feet per minute) and consequently offer little assistance to the handicapped patron. However, there are spacious slow-moving elevators which permit comfortable maneuvering of wheelchairs, and whose telephone and controls are within easy reach for most users.

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[1] Levine, R. BART and the Handicapped. Document #WP12-17 prepared by MTC for U.S. Department of Transportation. Berkeley, 1974.

[2] "Special Group Mobility Survey and Analysis." Presented in the BART Impact Program Transportation System and Travel Behavior Report prepared by Jefferson Associates in conjunction with the Center for Independent Living (in publication by MTC).

They are also marked with the universal symbol of the handicapped and the Braille symbol for the blind. The locations of the elevators, however, are often remote and a lack of clear directional signs makes it difficult to find them. New patrons needing to use the elevator in a particular BART station must call BART Passenger Information Service before a trip to ascertain the elevator's exact location; the location of the elevator is usually not obvious upon arrival at a station. After reconsideration, BART now plans to install signs directing patrons to elevators and to prepare a manual for the handicapped which will include layouts of each station and other helpful information. Currently, a task force of handicapped persons advises BART about desired improvements to facilities and allocation of resources to that end.

What economic consideration is given to the handicapped patron?

A new program for regional transit fare discounts for the handicapped went into effect July 1, 1975, allowing participants discount fares on all public transit systems including BART.[1] The BART fare for handicapped patrons is ten percent of the standard fare.

## MOVEMENT WITHIN THE STATION

How is movement facilitated for handicapped people?

In order to facilitate mobility for handicapped people, BART has provided entrance gates adjacent to station agent booths wide enough to admit wheelchairs. Fare-vending equipment, change machines and telephones can be reached easily from wheelchairs. Restroom facilities have wide doors, handgrips and specially-designed appliances for the handicapped. Stairways have handrails that extend beyond the top and bottom steps and resting platforms between flights. Closed-circuit TV monitors are placed so that agents can observe the passage of handicapped persons through elevators and other difficult areas. Station agents and train personnel have been specially instructed in how to assist the handicapped when necessary.

What aids to orientation are provided for the blind and near-blind patrons?

Orientation is a special problem for blind patrons who must rely on non-visual cues to find their way in a BART station. Levine[2] states that:

> ....Station areas are unmarked indeterminate expanses of space. No textured paths, no audible signals exist to suggest the correct direction of travel. To maneuver in the system from the time of arrival through the purchase of a ticket, to boarding a train, a blind person unfamiliar with the system must depend on someone else as a guide.

---

[1]Purchase permits are necessary and available only in certain locations; discount tickets may be purchased in many banks.

[2]Levine, op. cit., p. 26.

Although a blind person can learn to navigate any station with experience, there are several complicating factors, some of which represent potential danger:

- Stairways have no textural differentiation in the approach area. Even though escalators are well marked, they are generally less likely to be used by the blind.

- In some cases, structures angling upward and outward from the floors are not protected by railings or raised surfaces on the ground. Advertising kiosks is an example. Consequently, blind persons using canes can walk into them before they detect the obstruction. However, BART has begun a program to install guard rails around all places which may be hazards for blind people.

- The inconsistency of public address announcements[1] both on the platform and on the train necessitates asking other riders for assistance in boarding and leaving the proper train.


PHOTO 7.1

ADVERTISING KIOSK WITHOUT GUARDRAIL (EL CERRITO PLAZA)

[1]See Chapter Two for a general discussion of the BART communications system.

- Platform edge warning strips are inconsistent from station to station, both visually and texturally.[1] Some cannot be detected by blind persons at all. In one MTC survey (in which handicapped persons made judgments on their experience), Levine[2] states that:

> Only those stations in which materials used at platform edges varied markedly from those used for the total platform, could blind persons detect the area leading to the edge of the platform.

Additionally, even if warning strips are texturally distinct and thus discernible to the blind patron, there are no textural indicators for door stop locations, thus creating confusion.

Can a handicapped patron make use of the elevator system with ease?

The ease of using an elevator depends upon its location in the station with respect to other elements. In some stations it is very simple and in others it is complex and time-consuming. Because the elevator must pass from free to paid areas of the station (with ticket-processing taking place at some interim point), the patron must take an elevator from the street to the concourse level of a station, purchase (unless a previously purchased discount ticket is used) and present the ticket to a station agent who then processes the ticket in the AFC system. (A non-handicapped rider would then pass through the ticket gate at this point.) After the ticket is returned to the handicapped person, he or she must continue the trip to the train platform via the same or another elevator.

This procedure is relatively simple if elevator entrances are located close to an auto access point on the street, near the station agent's booth on the concourse and close to the central area on the platform level. Several of the suburban stations have elevator facilities arranged in this way. However, since the decision to provide elevators in all the BART stations was made after construction had begun, many designs could not accommodate elevator locations which are easily used by the handicapped. Use is difficult when:

- Elevator street entrance is (a) inconveniently located for automobile access, (b) at a considerable distance from the main entrance to the station (North Berkeley or MacArthur) and/or (c) obscurely situated so that locating it is difficult without direct assistance (19th Street-Oakland).

---

[1] See Chapter Three for further discussion regarding platform edge markings.
[2] Levine, op. cit., pp. 35-36.

- The elevator entrance at the concourse level is a considerable distance from the station agent's booth, the ticket gates, or another elevator which goes to the platform (Lake Merritt, 19th Street, MacArthur, or 16th & Mission, for example).

- The train platform elevator entrance is located at one end of the platform, unprotected and away from a central location (MacArthur Station, Photo 7.3).

PHOTO 7.2

ELEVATOR ENTRANCE ON PLATFORM (MAC ARTHUR)

- The elevator structure is in an unexpected location (Berkeley -- behind locked doors and down a dimly lit passageway) or an unusual structure (such as South Hayward, Photo 7.4).

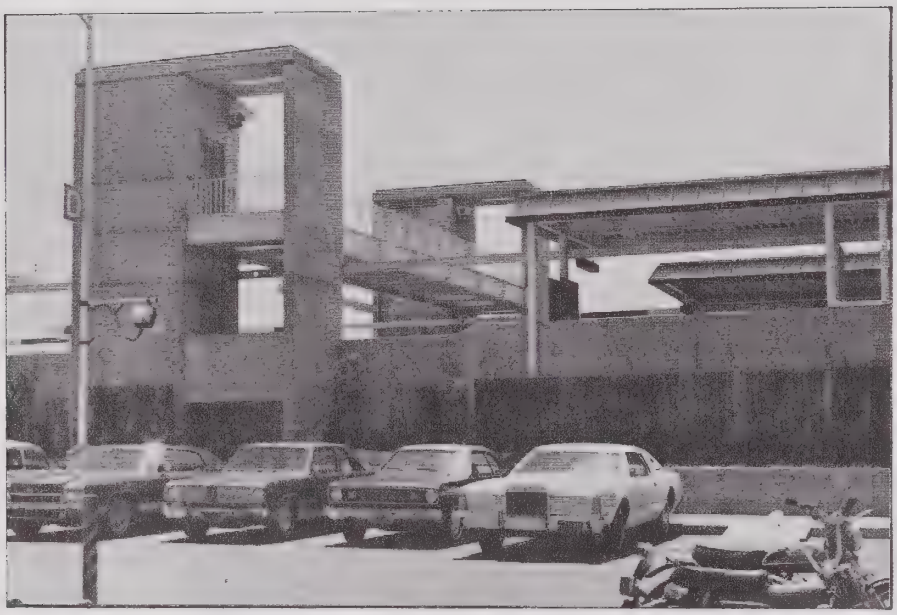

PHOTO 7.3

ELEVATOR
STRUCTURE
(SOUTH HAYWARD)

- Any segment of the handicapped patron's elevator travel requires the use of the intercom telephone system. Because elevator mechanisms must be actuated by station agents in most stations, users need to contact them, sometimes by using an often unreliable intercom phone. In the intercoms originally installed in most stations, there is virtually no way for the patron to determine whether his phone signal is being transmitted unless there is an immediate response to his call. Additionally, people with motor difficulties involving the arm and hand often cannot hold the phones in order to use them (Photo 7.4). As a remedy to this situation, BART plans to install push-button intercoms in all stations (such as the ones at the new Embarcadero Station) which are much easier to use, more reliable and less subject to vandalism.

The presence of any or all of these factors was observed to cause elderly patrons delay and additional movement which could be very tiring. Low mobility patrons surveyed indicated a general negative reaction to layout of elevators and the distances they are forced to traverse to use the system.

The following stations were judged to be the most inconvenient for elevator usage:

MacArthur
12th and 19th Street Stations - Oakland
16th and 24th Street/Mission Stations - S.F.
Lake Merritt
South Hayward

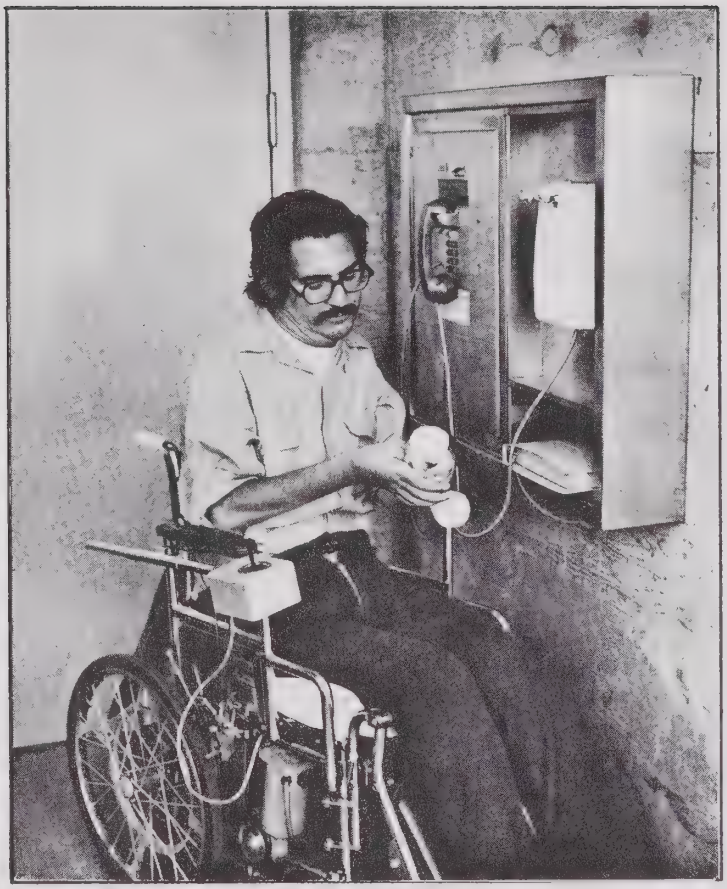

PHOTO 7.4

TYPICAL INTERCOM PHONE AT MOST BART STATIONS

RIDING ON THE TRAIN

What special problems do handicapped people face during a ride on BART?

Handicapped BART patrons have additional difficulty in boarding the train and frequently need extra space for the accessories necessary to their mobility. A wheelchair patron faces a variety of problems including having his wheelchair snagged in the gap between train and platform unless he boards backwards. Although this creates an annoying situation, it is not particularly dangerous since the doors will not close nor the train move until the wheelchair is freed. More importantly, there are no special locations for him, and he may frequently have difficulty keeping the wheelchair stable during acceleration and deceleration of the train.[1] It has been helpful, therefore, to inform the wheelchair patron that there is more room in the vestibule area near the doorways and to turn his wheelchair sideways to retard forward/backward motion. The lack of handholds near the doors and side seats makes movement and maintenance

[1]Levine, op. cit., p. 35

of balance difficult for the semi-ambulatory patrons who may be using crutches or canes. This is particularly acute during rush periods. However, no accidents involving wheelchairs have been reported. Persons who are unable to see visual indicators for train destinations must depend on unreliable public address announcements or assistance from others unless they resort to counting the stops between their points of departure and destination. A seeing-eye dog may ameliorate some of the blind persons difficulties, but the animal can often create an obstruction in the aisles. No complaints about this were found, however.

What is the general procedure for handicapped patrons after the train ride is completed?

As in their arrival at a BART station, the severely handicapped patron must depend on private transportation in order to complete his trip. Handicapped patrons indicated in the survey that they must rely heavily on station agents for information regarding proper exits and connecting modes of transportation. In fact, at present, the station agent appears to be the key factor in enabling the handicapped patrons to make a smooth journey through the BART system.

# CHAPTER EIGHT

## BART AND BICYCLES

In response to the recent trend toward use of bicycles for transportation as well as recreation, BART has provided bike storage facilities at its suburban stations. A program allowing patrons to transport bicycles on BART, with some restrictions, has also been implemented.

### BICYCLE ARRIVAL

Is it easy and safe for a bicyclist to reach the dismount point in BART stations?

Although no special provisions were made for bicyclists to enter BART station areas, they can usually reach the main station entrance before dismounting. Since traffic is required to move slowly on BART properties (15 MPH), the bicyclist is relatively safe despite the presence of motor vehicles. The feasibility of using a bicycle to reach BART is primarily determined by the surrounding environment. Key factors include the terrain, traffic conditions, and travel distance. All of these vary considerably for each station. In general, however, the suburban stations in low-density areas are the most practical candidates for bicycle access.

### STORAGE

What facilities are available and do they provide adequate protection for bicycles?

It was originally recommended (Manual, Sec. 1.4) that parking for bicycles should be provided in sheltered areas adjacent to the main entrance. However, BART officials felt that such installations might obstruct passenger movement and placed the racks away from main areas of activity. This proved unsatisfactory, as bicycle thefts systemwide became a substantial crime problem. Recently, approximately 1,200 bike racks of an improved design have replaced the old ones. The new racks are located where there is high station activity and when possible, in sight of station agents (Photo 8.1).


PHOTO 8.1

BICYCLE RACKS
(LAFAYETTE)

PHOTO 8.2

BICYCLE RACKS
UNDER SHELTER
(ASHBY STATION)

(Photo 8.2), and many cyclists refuse to leave expensive bikes outside in rainy weather. At present, approximately 650 bicycle locker spaces are being installed, first in suburban stations, then in downtown stations. They are of a movable type and will be installed as demand becomes evident. Unlike the racks, which are free, the lockers rent for five dollars per month.

## THE BIKES-ON-BART PROGRAM

### What is it and how is it working?

The on-board bike program allows cyclists to bring their vehicles on BART trains with some restrictions, and is expected to expand considerably when weekend service begins. The program was developed in conjunction with two large bicycle organizations, the San Francisco and East Bay Bicycle Coalitions. As of October, 1976, over 2,200 permits had been issued to bicyclists allowing them to take standard bicycles on BART. Basically, the regulations are:

- Taking bikes down escalators is against the rules and lifting bikes over fare gates is discouraged.

- Folding bikes are allowed on the train anytime, anywhere. Actually, so are regular bikes if wheels are taken off and all the parts are placed in a large plastic bag. This is enough of a deterrent for most.

- Regular bikes must go in the last half of the last car on the train. All of the last car will be allocated if program use increases accordingly. Bicycles can be brought into the system anytime except during rush hours (6:30 AM to 9:00 AM and 3:30 PM to 6:30 PM).

BART officials stated that there are no restrictions on numbers of permits at present, but they expect use of this program to increase considerably when weekend service begins. Then, permit restrictions may be necessary. At present, according to BART officials, about 200 bicyclists a week are using this program.

## STATION

### Is it difficult to get through the stations and onto platforms with a bicycle?

There are ways of processing tickets and taking bicycles through stations that make the passage easy for all cyclists without presenting a nuisance to other patrons. Since cyclists are usually able-bodied, shouldering a bicycle up and down escalators or stairs is easily accomplished. The elevators can also be used by cyclists if necessary, although their locations are sometimes inconvenient.

Passing through the fare gates can be done either by lifting the bicycle over them or by processing a ticket and having the station agent open the service gate (as is done for wheelchair patrons). In either case, there is no problem. As long as cyclists are considerate of other patrons, they do not present a nuisance. This is especially true at present since few cyclists use the system.

TRAINS

Are the trains easy to get bikes on and off, and do the bikes present an obstruction to other patrons?

For the cyclist traveling with a standard bicycle, who is restricted to non-rush hours and to the last car of a train (Photo 8.3), entry or exit is easy and orderly. However, those cyclists with folding bikes, who travel anytime and are not restricted to a specific train location will present the same obstruction to other passengers as do strollers, carriages, and wheelchairs. The only inconvenience to the cyclist is that they must hold onto the bicycles during movement since there are no facilities to secure them. Again, none of these requirements has been found to cause problems.

PHOTO .8.3

BICYCLISTS ABOARD BART TRAIN

# CHAPTER NINE

## CONCLUSIONS AND IMPLICATIONS

In the preceding chapters, numerous findings concerning the BART environment were presented according to the specific areas encountered by the typical traveler and the experience of the special user. The purpose of this chapter is to draw key conclusions from these findings relevant to the major categories of effect, which are:

- Orientation
- Reliability
- Convenience
- Safety
- Security
- Comfort
- Enjoyment
- Non-travel Services

From these conclusions, implications for general policy and specific design considerations will be drawn for future transit system planning.

### KEY CONCLUSIONS

Without regard to categories, the study's most significant conclusions are:

- In most respects BART is a pleasure for the traveler to use, largely because of its high level of architectural quality, train interior design, and general amenity. In these areas it may surpass most, if not all, other transit systems in the world.

- The system's lack of travel time reliability appears to be a major weakness, and the resulting inconvenience to patrons is compounded by the lack of information provided them regarding the likely causes and duration of such delays.

- Despite BART's simplicity of use for experienced riders, it seems very complex to many new or infrequent users. This results in an unexpected and excessive reliance on the station attendants for even basic information.

### CONCLUSIONS BY CATEGORY: ORIENTATION

First-time, infrequent or handicapped users often find orientation difficult on BART.

The procedure for using the BART system is simple. An initiated, regular user (particularly the commuter) soon becomes absorbed in a smooth pattern of operation from the moment he enters one station until he steps off the train at another. However, for the infrequent or first-time rider, orientation can be difficult. Adequate information is available to travelers re-

garding a trip on BART, but the availability is not well-publicized. Although station graphics and directions concerning the fare-collection and train operation are complete and explicit, they are not in a form that can be readily utilized by most uninitiated riders. Consequently, the station agent must answer the same questions repeatedly. In fact, the most important and reliable source of information currently available to the BART patron is the station agent. Either the directives should be simplified and publicized or agents should be encouraged to create information aids specifically related to their own stations.

There are great differences in the ease of orientation between subway and above-ground stations. The above-ground stations are easier to use (initially, at least): they are less difficult to locate, easier to enter, and they do not have the orientation problems inherent in below-ground environments. Downtown subway stations are the most confusing because they are large, have multiple entrances and exits, and some, the San Francisco stations, serve all three BART lines simultaneously. In both subway and above-ground stations, information and directional signing is of great importance. Signs are needed adjacent to and within parking lots to facilitate circulation. Signs at nearby bus stops should have additional information regarding routes and destinations. Especially in larger downtown stations, exit signs on platforms and concourses should designate the streets to which they point. Bus stop locations should also be more clearly indicated.

On board trains, patrons can orient themselves by station designation signs which are very well placed and easy to see from inside the train. When trains are above-ground, patrons can readily discern landmarks through the train's large glass windows. Often a particular station can be recognized by the unique way the architect combined materials, colors and patterns. Announcements of approaching stations made over the train's public address system are extremely helpful if they are made with consistency and clarity, and early enough to enable patrons to prepare to exit.

Blind patrons appear to have the most difficulty of all the handicapped riders in orienting themselves to the BART system. They need adequate non-visual cues such as texturally differentiated platform edge markings and pathways through the stations. Reliable and consistent public address announcements aboard the trains are essential for the blind; otherwise, they must resort to asking other riders for assistance. Elevator locations should be clearly marked since the handicapped are dependent on them for movement between the various levels of the station.

## RELIABILITY

Travel time unreliability is the biggest problem of the BART system from the traveler's perspective.

Train delays are caused by many factors, including a high rate of mechanical failure and equipment which is sensitive to extreme weather. For travelers,

the consequences are unnecessary crowding during rush periods and erratic, undependable travel times. The patron is frustrated even further because this system is unable to keep him informed of the cause and duration of travel delays. It is apparent that faster dissemination of this important information to patrons and stations would reduce the frustration of delayed travelers.

The unreliability of the automatic fare collection (AFC) system equipment is sometimes an annoyance to patrons, but not a major one in comparison with the reliability problems of the trains and their control system.

## CONVENIENCE

Although generally a convenient system, a number of small problems have surfaced due to minor flaws in BART's overall design or malfunctions during operation.

BART stations are designed to encourage unobstructed circulation. However, parking lots are too small in many cases, and their internal circulation can be poor during rush periods; thus many patrons must park on the streets. In most stations the various areas (i.e., concourse, platform) are spacious enough to accommodate the volume of patrons using them. However, in the stations where the doors of arriving trains always stop at the same platform location, BART commuters form orderly transverse queues during rush periods while waiting to board. Unfortunately, these queues can obstruct the flow of passengers from escalators and stairs onto the platform. It was observed that this queuing pattern does not develop if the doors of the train do not stop at the same platform location each time they arrive. Lines for fare collection can also obstruct movement during rush periods if too few exit gates are in operation.

Secondly, it would be useful for change machines to be able to handle bills larger than one dollar, especially in isolated suburban locations where a patron can be greatly inconvenienced and possibly miss his train if he does not have a dollar bill.

On board the trains, the basic inconveniences are doors between cars which are difficult to open (even though inter-car movement is permitted) and the lack of handholds in the car vestibules where they are frequently needed.

Although many helpful design features have been incorporated into BART stations to benefit the handicapped, the fact that elevator facilities were included late in the design process produced serious consequences. Using the elevator has proven to be complicated, time-consuming and exhausting for the elderly or handicapped user. The primary reasons are (a) poor placement of elevators in relationship to the rest of the station operations; (b) mechanisms which can be activated only by station agents; (c) intercoms which are unreliable and difficult for some handicapped persons to use; and (d) an unusually complex fare-collection procedure.

On the trains, wheelchair patrons have stabilization problems during acceleration and deceleration unless they face sideways. No special location is provided for them so they must stay in or very near the vestibules which obstructs passenger flow. This situation could be alleviated somewhat if the side seats could be folded up during crowded periods.

Cyclists pass through stations in a relatively easy manner. On trains they present no obstruction to other passengers since regular-sized bikes may be boarded in only off-peak hours and must be placed in the last car of the train. Folding bikes, however, are permitted in any car and can create obstructions during periods of heavy passenger flow.

## SAFETY

BART stations and trains are, in general, very safe from accidents.

Although actual accidents are rare in station parking lots, traffic circulation problems sometimes contribute to a higher accident risk than is necessary. The basic causes are inadequate signing, poor circulation patterns, high user volumes, and travel mode mix (autos, buses and pedestrians) near some entrances. Within stations, accident rates are also low; most of them occur as patrons move from one level of the station to another. The probable contributing factors are (a) rapid escalators (120 FPM for BART vs. 90 FPM for a typical department store unit); (b) smooth-surfaced stairways which become slippery during rainy periods despite the use of non-slip treads; and (c) children playing on escalators and stairs. Crowding was not found to be a contributing factor in most accidents even though the majority of accidents occur during rush periods. However, when the platform is overly crowded, there is some perceived risk of patrons slipping or falling over the edge. This danger is minimized when there are edge markings which contrast texturally and visually with the rest of the platform surface.

There are fewer accidents on trains than in stations, and they occur primarily when patrons are boarding or alighting from the cars. If there were a warning signal that the doors are about to close, and if the gap between platform and train were a uniform two inches, the already low accident rate could be reduced even further.

The BART system was designed to minimize situations which might endanger the well-being of its handicapped patrons. A few hazards do exist, however. Wheelchairs can be caught in the two-inch gap between the train and platform unless their users know how to board backwards. Blind patrons can walk into obstructions which slope outward and upward (undersides of escalators, advertising kiosks, etc.) unless a low barrier is placed around them that is detectable by a tapping cane. Textural differentiations in edges of the platforms and approachways to stairways are as essential to the safety of the blind person as they are to his orientation in general.

SECURITY

BART trains and stations are virtually crime-free, with the exception of parking lots which are focal points for auto thefts and burglaries. Crimes to persons are minimal.

In some BART parking lots, autos are subject to burglary and theft because: (a) lots are often large and not easily visible to station personnel, (b) there is little surveillance by BART and local police, and (c) the lots are sometimes located in neighborhoods with high crime rates.

Loiterers can be annoying to patrons in downtown station plazas (notably Hallidie Plaza at Powell Street), despite the validity of the contention that these areas are the only "park" spaces available to the elderly or indigent residents of such parts of the city. Bus stops near BART stations are safer if they are located near station entrances. Within the station, the greatest crime problem is fare evasion which is encouraged by fare gates that are quite low. Bike theft was originally a problem for BART patrons, but it has been virtually eliminated by redesigned bicycle racks placed in more visible locations.

On board the trains, drunks are occasional nuisances but, in general, BART patrons are amiable. Riders can receive emergency assistance in both trains and stations by using one of the intercom phones which are located throughout the BART system. The emergency system could be improved greatly if the existence of the intercom were well-publicized and if the phone mechanisms themselves were more reliable. Furthermore, response time to emergency calls varies somewhat because of the limited manpower of BART police and the difficulty of responding to problem situations which occur aboard moving trains. However, cooperation between BART and the local police departments along its right-of-way gives faster response capabilities during emergencies. This has apparently worked satisfactorily to date, although it has not often been necessary.

COMFORT

Comfort varies, but is generally excellent throughout the BART system except during periods of high-volume usage.

No station platform in the BART system contains seating which adequately meets the needs of its patrons during peak periods. Originally, trains were projected to run more frequently than in fact they do; and a sparse seating arrangement would have been appropriate if waiting periods were minimal. They are not; consequently, seating capacities on the platforms should be expanded (beyond recent increases). Wind screens, recently installed at all above-ground stations, have relieved the major problem of exposure to the elements.

Subway station ventilation depends upon the "piston effect" of the approaching train for circulating the air. When service is interrupted, conditions can

become unpleasant; auxiliary fans should be used, although they are often not. This is particularly true during hot weather. BART is generally acknowledged to be a "quiet" system. Sound levels in both above- and below-ground stations are dominated by BART train noises. Architectural design and insulation have been used to lessen sound. However, the condition of the tracks seems to be a major determinant of sound and vibration levels both in the station and aboard the train.

On any transit vehicle the most important comfort factors are generally found to be seating availability and temperature control.[1] Seating is generally available on the trains except during rush periods when there are up to three times as many riders as seats. The planned eventual increase in train frequencies will alleviate this problem.

In general, seating comfort is excellent due to spacious construction and luxurious padding. The BART vehicle seating configuration has only half of its seats facing forward; patrons almost always choose the forward-facing seats first. This pattern enhances the versatility of the cars, but movable seat backs would permit greater flexibility.

Air conditioning is adequate regardless of passenger load, and the system itself is generally reliable except during very hot weather. During periods of bright sunlight, heat radiated through the large windows can make passengers uncomfortable, but this occurs infrequently and only at certain times of the day. Ride comfort is most adequate for sleeping or reading, but writing can be difficult. Interior train lighting is excellent both above-ground and in subway sections, and the contrast between daylight and interior illumination is minimal.

## ENJOYMENT

From both the aesthetic and the functional viewpoints, BART trains and stations are on the whole well-designed.

Because the Manual design requirements specified dimensions and locations of main station elements, BART stations have a high degree of functional consistency. Station individuality, however, was encouraged and achieved by variations in design details, most notably in floor and wall materials and in lighting effects. Advertising and art work are also used to enhance the aesthetic appeal of many stations. Stations are well-maintained and generally pleasing environments.

Trains are modern and sleek in appearance with luxurious interiors which are also durable and easy to maintain. The cantilevered seats and electrical outlets for standard appliances facilitate the maintenance procedure and thus contribute readily to the passenger's enjoyment of a train which is nearly always clean and orderly. One of the primary enjoyments for a patron who travels the 51 miles of above-ground trackway is the BART's-eye view of the San Francisco Bay Area. This factor makes BART a popular tourist attraction; it also makes daily commuting more pleasurable.



[1]Wachs, op. cit., p. 103

In both trains and stations, graffiti and signs of vandalism are, by policy, removed immediately in an attempt to discourage more of the same. This policy seems to be effective.

## NON-TRAVEL SERVICES

Although the services provided are well received, more are needed.

Station design was based on the premise that patrons would be in the stations for a very short time. Hence, few amenities were provided. However, since the original premise proved untrue because of BART's unreliable travel time, a few additional amenities are needed; more telephones on the platform would be of particular value to passengers waiting for delayed trains

The most notable non-travel service provided is restroom facilities which are opened electrically by the station agents. Patrons can enjoy complete privacy and safety. Although some patrons dislike locating an agent in order to gain entrance, there is virtually no crime in these facilities -- a considerable achievement given that restrooms have been a high crime rate location in many urban transit systems.

## LESSONS LEARNED: IMPLICATIONS FOR FUTURE TRANSIT SYSTEMS PLANNING

To this point, the study findings and conclusions have been presented specifically for the BART system without comment as to their usefulness for future systems planning elsewhere. This section suggests some of these applications, derived both from BART's successes and its shortcomings.

The creation of a new rapid transit system is a complex and lengthy process. Initially, the problems are on the level of finance and policy making, but as the commitment becomes deeper, design issues arise which are increasingly more detailed. Many of these decisions concern the potential traveler directly.

At the beginning, decision makers must consider one main issue: Within the constraints of budget and technology, what kind of a system will best serve the potential user? All the design issues which relate directly to the traveler's experience, from general to specific, stem from the eight travel determinant categories discussed earlier in the study. This design process suggests a corresponding way to present this study's implications; that is, from general to specific, as follows:

- General policy design.
- Overall station design.
- Station details.

- Overall vehicle design.
- Vehicle details.

General Design Policy

- Ease of Use -- The transit system should be as simple as possible to use, and that simplicity must be communicated clearly and concisely so it does not appear complex.
- Break-in Period -- The ultimate design level of service on a new transit system may not be attainable for a considerable period of time when operation begins. Station facilities should be designed to comfortably accommodate the travelers during the possible delays and crowded conditions.
- Sound Level Standards -- Even though recently recommended Institute of Rapid Transit Guidelines for maximum sound levels are exceeded somewhat in stations and aboard trains, BART is generally acknowledged to be a quiet system. (Perhaps the design levels recommended should be re-examined.)
- Passenger Announcements -- A communication system must be integrated into the transit facilities which allows rapid dissemination of information to travelers anywhere in the system. Any data regarding travel delay, durations and causes, should be immediately interpretable into information useful to the traveler and rapidly communicated.
- Languages -- The system should be made accessible to those who cannot speak English. International symbols and graphics which transcend language barriers should be used whenever possible to replace the written word.
- Handicapped -- All facilities should be designed initially with the handicapped in mind. This should include consideration of the problems of orientation of the blind and obstructions to movement of those with severe motor disabilities.
- Emergency Aid -- Emergency help should be available quickly -- not so much of necessity, but because its potential is a great deterrent to crime. Emergency communication equipment should be a part of the main communication system and a procedure worked out to provide aid anywhere on the system as rapidly as realistically possible. All emergency equipment should be well identified and publicized.
- Seating Capacity -- Train frequency should be planned to provide the majority of peak-period patrons with seats, both for comfort and safety.

- Track Maintenance -- Tracks must be maintained to a high level in order to eliminate unnecessary noise and vibration and to insure ride quality.

- Weather Protection -- Wherever patrons must wait in stations (at nearby bus stops or on above-ground platforms), weather protection should be provided. Overhead protection is most important, but adequate transverse shelter from the wind is often also necessary.

- Bicycles -- Use of bicycles should be encouraged by providing adequate storage facilities at stations and by establishing procedures for bicycles to be brought on board trains without inconveniencing other patrons.

Overall Station Design

- Consistency and Variety -- Stations should be designed so that they are functionally and spatially consistent in their various elements, thus facilitating easy orientation by travelers. However, variations in details of architectural appearance from station to station should be allowed, both for interest and station identification.

- Parking Lots -- Station and parking lot entrances should have circulation patterns which facilitate traffic flow and separate modes of travel with directions well defined by signs. The parking lots should be under surveillance occasionally and non-routinely by transit or local police, and they should be in view of station agents if possible.

- Interior Size -- Both "paid" and "free" areas of concourses should be of sufficient size to accommodate large numbers of patrons queuing to use fare collection machines, escalators and stairs during rush periods without excessive and dangerous crowding.

- Ventilation -- There should be an auxiliary air circulation system in subway stations to supplement normal ventilation provided by train "piston effect" when service interruptions or unusually hot weather occurs.

- Signing Policy -- Adequate and consistent signing is a must throughout the station. Especially important in larger stations are exit signs indicating street destinations above and informational signs directing travelers to connecting modes of transportation.

- Station Agent's Post -- A station agent's booth should be located so there is no obstruction in the view to all fare collection devices and other functional equipment on the concourses. Closed circuit TV monitors should be used whenever this is not possible. Handicapped facilities should be located in the vicinity of the agent's booth.

Station Details

- Equipment Reliability -- The highest emphasis should be placed on the reliable operation of all fare dispensing and collection machinery.

- Change -- Change machines that cannot handle bills larger than $1 are not sufficient. They should be more versatile without sacrificing reliability.

- Fare Evasion -- Fare gates should be tall enough or otherwise designed to discourage easy fare evasion by jumping the gate.

- Location of Level Changes -- Escalators, elevators, and stairs should be located as close as possible to centers of station activity, thus minimizing needless traversing on concourses. Locations should be clearly indicated by signs.

- Elevator Facilities for the Handicapped -- Elevators for the handicapped should be self-service in operation with optional override control by station agent if a specific situation warrants it. At street entrances, their location should be near the auto drop-off/pick-up point; at concourses, near the station agent; and on platforms, near the center.

- Aids to Blind Patrons -- Textured paths and platform edge markings or other non-visual cues should be standard in stations as aids to orientation of the blind. There should also be regular, consistent announcements over the PA system on platforms announcing destinations of all incoming trains. Particular features in stations which might not be detectable by a blind person with a tapping cane (such as undersides of escalator and upward sloping kiosks) should be protected by a guard rail of some sort.

- Restrooms -- Restrooms should be included in transit system stations, but there should be entrance control by agents and patrons should be able to lock restroom doors for privacy and security.

- Platform Seating -- Where space allows, ample seating should be provided on platforms if waiting times are more than a few minutes.

- Destination Information -- Simple local area orientation aids should be provided in each station rather than relying entirely on standard systemwide displays. Agents should be encouraged and aided in developing informational graphics pertaining to the particular station situation. Automated maps could also be designed on which a button pushed next to final destination would illuminate the route through the system in addition to displaying fares, and travel time (much like the maps in the Paris Metro).

- Telephones -- Several telephones should be installed on all platforms to allow patrons to make calls without the risk of missing a train.

- Bicycle Protection -- Bicycle racks should be designed to protect bicycles adequately from theft. They should be sheltered from weather and located near centers of activity, preferably within view of station agents for easy surveillance.

- Train-to-Platform Space -- Gaps between trains and station platforms should be consistently as narrow as possible, particularly for wheelchair access.

Overall Vehicle Design

- Train Exterior Surface -- Train exteriors should be attractive but easy to clean so that appearance can be maintained with minimal effort.

- Interiors -- Train interiors should be simple, durable and easy to maintain.

- Ride Quality -- The vehicle should ride smoothly enough so patrons can read or snooze comfortably without vibration and sound levels which are by standards considered "unpleasant."

Vehicle Details

- Seating Design -- Seats should be spacious (as BART's are) but perhaps not as luxuriously upholstered. Reversible front or rear-facing seats should be considered.

- Handholds -- Handholds should be provided wherever patrons may stand during crowded conditions, particularly in the vestibules.

- Emergency Aid -- Emergency intercoms and other equipment locations should be plainly marked.

- Climate Control -- Air-conditioning and heating systems are a necessity for patrons' comfort, and they should be reliable under all conditions.

- Obstructions -- Specific ways should be devised to accommodate patrons who board the train with bicycles, wheelchairs and other accessories without obstructing the movement of other passengers. Examples:

  -- Center-facing seats near doors could fold up.

  -- Specific sections on the train could be reserved for such patrons.

  -- Mechanisms could be installed in each car to secure wheelchairs in a stable position during movement and to release quickly for train exit.

- Movement Between Cars -- If patrons are to be allowed to pass from car to car, doors between cars should open easily.

## TRAVEL INDUCEMENT AND IMPEDANCE: A FINAL NOTE

This study of the BART user's experience has dealt with a great many aspects of BART facilities and operations, as well as a broad range of their effects on the traveler. Fairly strict limits were imposed on the study by the availability of data as well as budget. Nonetheless, it presents a comprehensive and, we believe, accurate picture of BART as an environment through which the traveler moves.

The effects of this environment on the traveler were found to have many dimensions. Insofar as possible, these were grouped according to major categories similar to those conventionally used in theories and resulting indicators of mode choice behavior. The results indicate that BART scores highly on most of these, including comfort, safety, security, enjoyment, and general amenities. However, these are generally agreed to be of relatively little importance in determining the urban traveler's choice of mode. Unfortunately, BART's major weakness, service and equipment reliability, is a system characteristic important to the traveler.

This perspective adds emphasis to perhaps the greatest lesson of all: In the design of mass transit facilities, it is hardly possible to lay too much stress on insuring the reliable, fast, and convenient operation of the system. BART provides many positive examples of high-quality design for the user, which should be respected and incorporated into the design of systems elsewhere. But most importantly, its continuing difficulties in providing what the traveler wants most -- a fast, convenient and, above all, reliable trip -- must be remembered and avoided in future systems. Otherwise the confidence and support needed, from patrons and the general public alike, can neither be generated nor maintained.

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# APPENDICES

# APPENDIX A
# SOUND LEVEL RECORDINGS IN TRAINS AND STATIONS

Table A.1
SOUND LEVELS IN BART STATIONS

| STATION | STATION STRUCTURE | $L_{eq}$ - dB(A) W/O TRAINS | $L_{eq}$ - dB(A) W/TRAINS | $L_{max}$ - dB(A)* ARRIVE | $L_{max}$ - dB(A)* DEPART |
|---|---|---|---|---|---|
| Daly City | At-grade | 64 | 83 | $85/_{0.4}$ | $94/_{2.8}$ |
| Concord | At-grade | 54 | 80 | $83/_{1.2}$ | $91/_{2.0}$ |
| S. Hayward | At-grade | 55 | 66 | $70/_{1.2}$ | $72/_{1.5}$ |
| Coliseum | Aerial | 69 | 72 | $77/_{1.1}$ | $81/_{2.4}$ |
| Rockridge | Aerial | 77 | 78 | $81/_{0.5}$ | $86/_{1.1}$ |
| Embarcadero | Subway | 52 | 70 | $77/_{2.4}$ | $78/_{2.2}$ |
| Montgomery | Subway | 57 | 70 | $75/_{3.2}$ | $80/_{2.0}$ |
| 16th/Mission | Subway | 54 | 72 | $79/_{1.6}$ | $81/_{1.5}$ |
| 19th Street | Subway | 56 | 73 | $77/_{2.8}$ | $86/_{2.8}$ |

* The first value is the mean of eight samples at each location. The second value is the standard deviation of the sample population.

Source: Bolt Beranek and Newman, Inc. 1976.

Table A.2
SOUND LEVELS ON BART TRAINS

| TRIP SEGMENT | DURATION (Minutes) | MICROPHONE LOCATION (Seat Number)* | $L_{eq}$ - dB(A) | $L_{max}$ - dB(A) |
|---|---|---|---|---|
| Montgomery-Concord | 42.3 | 5 | 76 | 89 |
| Concord-Montgomery | 40.2 | 17 | 75 | 86 |
| Montgomery-Daly City | 13.8 | 13 | 77 | 88 |
| Daly City-Montgomery | 14.2 | 14 | 81 | 92 |
| Montgomery-Fremont | 44.5 | 13 | 75 | 87 |
| Fremont-12th St. Oakland | 29.5 | 35 | 79 | 91 |
| 12th St. Oakland-Richmond | 18.9 | 35 | 77 | 87 |
| Richmond-Montgomery (MacArthur Transfer) | 35.4 | 6,11 | 76 | 87 |

* See Figure 5.1 for seat locations

Source: Bolt Beranek and Newman, Inc. 1976.

# APPENDIX B
# STATION FACILITIES AND VEHICLE DESIGN DATA

Table B.1
BART STATION ARCHITECTS

| Stations | Project Architects | Landscape Architects |
|---|---|---|
| Embarcadero | Tallie B. Maule/Hertzka & Knowles Associates | Sasaki-Walker Associates |
| Montgomery Street | Skidmore, Owings & Merrill | |
| Powell Street | Skidmore, Owings & Merrill | |
| Civic Center | Reid & Tarics | |
| 16th Street Mission | Hertzka & Knowles | Theodore Osmundson |
| 24th Street Mission | Hertzka & Knowles | Theodore Osmundson |
| Glen Park | Corlett & Spackman/Ernest Born | Douglas Bayliss |
| Balboa Park | Corlett & Spackman/Ernest Born | Douglas Bayliss |
| Daly City | Gerald M. McCue & Associates | Theodore Osmundson |
| Richmond | Maher & Martens | Royston, Hanamoto, Beck & Abey |
| El Cerrito Del Norte | DeMars & Wells | Sasaki-Walker Associates |
| El Cerrito Plaza | DeMars & Wells | Royston, Hanamoto, Beck & Abey |
| North Berkeley | Kitchen & Hunt | Royston, Hanamoto, Beck & Abey |
| Berkeley | Maher & Martens | Royston, Hanamoto, Beck & Abey |
| Ashby | Maher & Martens | Royston, Hanamoto, Beck & Abey |
| MacArthur | Maher & Martens | Royston, Hanamoto, Beck & Abey |
| Concord | Gwathmey, Sellier & Crosby/ Joseph Esherick & Associates | Anthony Guzzardo |
| Pleasant Hill | Masten & Hurd/Joseph Esherick & Associates | Anthony Guzzardo |
| Walnut Creek | Masten & Hurd/Joseph Esherick & Associates | Anthony Guzzardo |
| Lafayette | Gwathmey, Sellier & Crosby/ Joseph Esherick & Associates | Anthony Guzzardo |
| Orinda | Gwathmey, Sellier & Crosby/ Joseph Esherick & Associates | Anthony Guzzardo |
| Rockridge | Maher & Martens | Royston, Hanamoto, Beck & Abey |
| 19th Street Oakland | Gerald M. McCue & Associates | |
| 12th Street Oakland | Gerald M. McCue & Associates | |
| Oakland West | Kitchen & Hunt | Robert Kitchen |
| Lake Merritt | Yuill-Thornton, Warner & Levikov | Douglas Bayliss |
| Fruitvale | Reynolds & Chamberlain/ Neill Smith | Anthony Guzzardo |
| Coliseum | Reynolds & Chamberlain/ Neill Smith | Anthony Guzzardo |
| San Leandro | Masten & Hurd/Joseph Esherick | Anthony Guzzardo |
| Bay Fair | Masten & Hurd/Joseph Esherick | Anthony Guzzardo |
| Hayward | Wurster, Bernardi & Emmons | Ralph Jones |
| South Hayward | Kitchen & Hunt | Robert Kitchen |
| Union City | Kitchen & Hunt | Robert Kitchen |
| Fremont | Kitchen & Hunt | Robert Kitchen |

Source: Betts, R., "Design of Bay Area Rapid Transit Stations", (Master's thesis), U. of California, Berkeley, (1973).

Table B.2
BART STATION FACILITIES

| BART Station | Structure: Elevation | Platform Type | Internal Access: Elevators | Escalators | Automatic Fare Equipment: Faregates 1973 | Faregates 1976 | Ticket Vendors 1973 | Ticket Vendors 1976 | Change Machines 1973 | Change Machines 1976 | Add-Fare Machines 1973 | Add-Fare Machines 1976 | Other Facilities: Public Restrooms | Bus Shelters |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fremont | Surface | Center | 1 | 2 | 3 | 6 | 2 | 4 | 2 | 3 | 1 | 2 | 2 | 4 |
| Union City | Aerial | Side | 2 | 2 | 3 | 8 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| South Hayward | Surface | Side | 2 | 2 | 3 | 4 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 1 |
| Hayward | Aerial | Side | 2 | 2 | 6 | 8 | 3 | 5 | 3 | 4 | 1 | 3 | 2 | 1 |
| Bay Fair | Aerial | Center | 1 | 1 | 3 | 8 | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 1 |
| San Leandro | Aerial | Side | 2 | 4 | 4 | 5 | 4 | 5 | 3 | 4 | 1 | 3 | 2 | 2 |
| Coliseum | Aerial | Center | 2 | 4 | 8 | 13 | 3 | 9 | 5 | 6 | 1 | 3 | 2 | 3 |
| Fruitvale | Aerial | Side | 2 | 4 | 6 | 7 | 5 | 4 | 4 | 3 | 1 | 2 | 2 | 1 |
| Lake Merritt | Subway | Center | 2 | 4 | 6 | 8 | 5 | 7 | 5 | 4 | 2 | 3 | 2 | 1 |
| 12th Street Oakland | Subway | Side | 2 | 17 | 9 | 16 | 3 | 8 | 6 | 6 | 3 | 6 | 2 | |
| 19th Street Oakland | Subway | Side | 2 | 13 | 9 | 16 | 3 | 7 | 6 | 7 | 3 | 6 | 2 | |
| MacArthur | Surface | Center | 2 | 4 | 3 | 6 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 2 |
| Ashby | Subway | Center | 1 | 2 | 3 | 4 | 2 | 3 | 1 | 3 | 1 | 2 | 2 | 2 |
| Berkeley | Subway | Center | 2 | 3 | 12 | 12 | 4 | 7 | 3 | 6 | 3 | 6 | 2 | |
| North Berkeley | Subway | Center | 1 | 2 | 6 | 10 | 2 | 3 | 2 | 4 | 2 | 3 | 2 | 2 |
| El Cerrito | Aerial | Side | 2 | 2 | 3 | 4 | 1 | 3 | 1 | 3 | 1 | 2 | 2 | |
| El Cerrito Del Norte | Aerial | Side | 2 | 2 | 6 | 8 | 2 | 3 | 1 | 4 | 1 | 3 | 2 | |
| Richmond | Surface | Center | 2 | 2 | 3 | 4 | 1 | 2 | 1 | 3 | 1 | 2 | 2 | 3 |
| Concord | Aerial | Center | 1 | 2 | 3 | 7 | 1 | 4 | 2 | 4 | 1 | 3 | 2 | 2 |
| Pleasant Hill | Aerial | Side | 2 | 2 | 3 | 6 | 1 | 4 | 2 | 3 | 1 | 2 | 2 | 3 |
| Walnut Creek | Aerial | Side | 2 | 2 | 3 | 7 | 1 | 4 | 2 | 3 | 1 | 2 | 2 | 4 |
| Lafayette | Surface | Center | 1 | 1 | 6 | 8 | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 1 |
| Orinda | Surface | Center | 1 | 1 | 3 | 5 | 1 | 4 | 2 | 3 | 1 | 2 | 2 | |
| Rockridge | Surface | Center | 1 | 3 | 3 | 4 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | |
| Oakland West | Aerial | Side | 2 | 2 | 3 | 4 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 2 |
| Embarcadero | Subway | Center | 2 | 14 | 12 | 22 | | 12 | | 4 | | 4 | 2 | |
| Montgomery | Subway | Center | 2 | 14 | 26 | 37 | 25 | 27 | 16 | 15 | 3 | 6 | 2 | |
| Powell | Subway | Center | 2 | 18 | 12 | 24 | 4 | 10 | 7 | 9 | 3 | 5 | 2 | |
| Civic Center | Subway | Center | 2 | 13 | 9 | 16 | 4 | 7 | 7 | 7 | 3 | 5 | 2 | |
| 16th Street Mission | Subway | Center | 2 | 3 | 4 | 5 | 1 | 3 | 2 | 2 | 1 | 2 | 2 | |
| 24th Street Mission | Subway | Center | 2 | 3 | 5 | 8 | 1 | 3 | 2 | 3 | 1 | 2 | 2 | |
| Glen Park | Subway | Center | 1 | 2 | 4 | 5 | 1 | 3 | 2 | 3 | 1 | 2 | 2 | 0 |
| Balboa Park | Subway | Center | 1 | 2 | 4 | 6 | 1 | 4 | 2 | 3 | 1 | 2 | 2 | 0 |
| Daly City | Surface | Center | 2 | 3 | 3 | 14 | 3 | 6 | 3 | 5 | 1 | 3 | 2 | 2 |
| Totals Needed | | | 58 | 157 | 199 | 325 | 97 | 180 | 108 | 141 | 47 | 100 | 68 | 38 |

a. Four-hour peak period. (Approximately 6:30 a.m. - 8:30 a.m. and 4:30 p.m. - 6:30 p.m.)

Source: BARTD Transportation Department

Table B.3

# VEHICLE DESIGN DATA

## Information, Requirements and Characteristics for Transit Vehicle for San Francisco Bay Area Rapid Transit District

### 1. SYSTEM DESCRIPTION:

(a) 75 miles of double track located in San Francisco, Alameda and Contra Costa Counties, California.

| | |
|---|---|
| On aerial structure | 27 miles |
| At grade | 28 miles |
| In tunnels and tubes | 20 miles |
| (b) Number of stations | 34 |
| Average distance between stations | 2.25 miles |
| Average duration of normal station stop | 20 seconds |
| (c) Number of vehicles (three county, 1975) | 450, approximately |
| (d) Anticipated annual car miles (1975) | 90,000 miles per car per year |

### 2. PERFORMANCE CHARACTERISTICS:

| | |
|---|---|
| (a) Maximum speed: | |
| Automatic control | 80 mph |
| Manual control | 25 mph |
| (b) System schedule speed | 45 mph |
| (c) Acceleration (80,000 lb. car weight.) | |
| Maximum allowed | 3.3 mphps, instantaneous |
| Maximum time to move 700 feet from stop | 20 seconds |
| (d) Deceleration: (96,000 lb. car weight.) | |
| Maximum allowed | 3.3 mphps, instantaneous |
| Full Service (80 mph to 0) | 3.0 mphps |
| Normal | 2.0 mphps |
| (e) Hostling speed (in yards) | 10 mph |
| (f) Jerk, maximum | 1.5 mphpsps |
| (g) Headways, scheduled | 90 second minimum |

### 3. TRACK AND ROADBED GEOMETRIC DATA:

| | |
|---|---|
| (a) Horizontal Curves: | |
| Car design basis | 400'R |
| Mainline minimum: | 500'R |
| Mainline turnouts: | # 8 – (581'R)<br># 10 – (973'R)<br># 15 – (2278'R)<br># 20 – (4066'R) |
| (b) Vertical Curves: | |
| Maximum rate of change | 1.5% per 100' (parabolic) |
| Usual rate of change | 0.4% to 0.8% per 100' |
| Maximum grades | 4% |
| (c) Continuous welded steel rail | 119# CF & I (canted 1:40) |
| (d) Track Gauge (tangent and curve) | 5'-6" (± 1/8") |
| (e) Track spacing (minimum) | 14'-0" (centers) |
| (f) Unbalance track superelevation | |
| Absolute maximum | 4½" |
| Usual | 2-3/4" |
| (g) Superelevation | |
| Absolute maximum | 8¼" |
| Usual | 6" |
| (h) Clearances (minimum after all wear and deflection) | 2" |
| (i) At stations: | |
| Maximum grade | 1.0% |
| Vertical alignment | Tangent (straight) |
| Horizontal alignment | Tangent (straight) |
| Station platform length | 700' |

Table B.3 continued

| | |
|---|---|
| **4. VEHICLE DESCRIPTION:** | |
| (a) Electrical propulsion rating | 600 hp/car, approx. |
| (b) Voltage at trackside contact rail | 4160 volt ac, or 1000 volt dc - (undecided) |
| (c) Battery voltage | 32 volts (24 to 40 volts) |
| (d) Weight: | |
| Empty vehicle - (assumed) | 56,000 lbs. |
| Full load - nominal | 72,000 lbs. |
| Occasional overload | 80,000 lbs. |
| Crush load - not more than | 96,000 lbs. |
| **5. CAR BODY:** | |
| (a) Minimum design life | 20 years |
| (b) Fixed sash in windows. Tinted glass. | |
| (c) Two double-leaf, bi-parting, sliding doors on each side of each car, equally spaced along train @ 35'-0". Width of opening | 4'-6" |
| (d) Body width (maximum outside dimensions) | 10'-6" |
| (e) Length of car (coupler faces) | 70'-0" |
| (f) Car height (top of rail to top of car) | 10'-6" |
| (g) Ceiling height (over aisle) | 6'-9" |
| (h) Floor height (from top of rail) | 3'-3" |
| (i) Truck spacing | 50'-0" |
| (j) Design impact load | .4 g. |
| **6. TRUCK DESCRIPTION:** | |
| (a) Wheel base | 8'-6" |
| (b) Wheel diameter (multi-wear) | 30" |
| (c) Wheel tread | (undecided) |
| (d) Wheel gauge | 5'-5 3/16" or greater |
| **7. CAR INTERIOR:** | |
| (a) Two-and-two, transverse seating arrangement, generally. | |
| (b) Seat width, per passenger | 22" |
| (c) Seat spacing, nominal | 34" |
| (d) Seats per car | 72 |
| **8. AIR COMFORT SYSTEM:** | |
| (a) Heating, cooling and ventilating modes shall be included: | |
| (b) Controls | fully automatic |
| (c) Heating by electric resistance heaters (in ducts) | 30 kw |
| (d) Cooling by electric motor driven vapor cycle | 10 tons |
| (e) Ventilation by electric motor running continuously. Total rate | 3,000 cfm |
| (f) Rating conditions inside | Winter, 72° F Summer, 78° F, 50% relative humidity |
| (g) Ambient design conditions outside | Winter, 24° F Summer, 100° F 30% relative humidity |
| (h) Humidity controls | None |
| (i) Fresh air flow | 1,000 cfm |
| (j) Air velocities in car | 15 to 65 fpm limits 25 to 35 fpm optimum |
| (k) Air duct velocities | 2,500 fpm, maximum |
| (l) Air distribution | Through under-window supply grills with air directed over glass. |

Source: Lawson, K.L., "Development of SFBART Vehicle", paper presented at the National Transportation Symposium, San Francisco, (May 1966).

# APPENDIX C
# PANEL QUESTIONNAIRE AND PASSENGER SAMPLE CHARACTERISTICS

## CHARACTERISTICS OF THE BART PASSENGER SAMPLE (9/76)

### TOTAL SAMPLE

| Age Distribution of Sample | | Travel Times | | Travel Characteristics* | | |
|---|---|---|---|---|---|---|
| Age Groups | # | Peak** | Off-Peak | Commuter | Irregular | Sometimes |
| Below 20 | 4 | 1 | 3 | 2 | 1 | 1 |
| 20-29 | 20 | 12 | 8 | 17 | 2 | 1 |
| 30-49 | 17 | 9 | 8 | 7 | 5 | 5 |
| 50-59 | 11 | 3 | 8 | 3 | 4 | 4 |
| 60 & over | 3 | 0 | 3 | 0 | 1 | 2 |
| Total | 55 | 25 | 30 | 29 | 13 | 13 |

### DISABLED RIDERS SAMPLE

| Riders | | Travel Times | | Travel Characteristics* | | |
|---|---|---|---|---|---|---|
| Disability | # | Peak** | Off-Peak | Commuter | Irregular | Sometimes |
| Vision Problems | 6 | 2 | 4 | 2 | 2 | 2 |
| Mentally Retarded | 2 | 1 | 1 | 1 | 1 | 0 |
| Heart Condition | 5 | 0 | 5 | 1 | 3 | 1 |
| Walking Difficulty | 4 | 1 | 3 | 0 | 1 | 3 |
| Wheel Chair | 1 | 1 | 0 | 1 | 0 | 0 |
| Total | 18 | 5 | 13 | 5 | 7 | 6 |

*Note: 1) Commuters - 4 or more round trips per week
2) Irregular riders - less than 4 round trips per week and more than 2 round trips per month
3) Sometimes - 2 or more round trips per month or less

**Peak: 7-9 a.m. - 4-6 p.m.

# BART TRAVELER EXPERIENCE STUDY

PART I: SCREENING INTERVIEW

DATE:_____ PANEL:_____

START TIME:_____ RESPONDENT #:_____

LOCATION:_____

INTRODUCTION:

Hello, my name is _____ and I'm working on a survey of BART riders. (SHOW IDENTIFICATION) This is part of a study of BART's effects on the Bay Area.

(IF NEEDED) The study is being done for the Metropolitan Transportation Commission, a state agency. The firms doing this study are Curtis Associates and De Leuw, Cather & Company, who are planning consultants.

I'd like to ask you just a few quick questions about your use of BART. I won't delay your trip.

1a. Do you make this trip regularly? Yes No (CIRCLE ONE)

b. How often? _____ days/week _____ other

2. Where do you get on & off? (STATION NAME) On:_____

Off:_____

3. And about when do you start and end your round trip?

START TIME_____ END TIME_____

4. Do you use BART regularly for any other trip? Yes No (CIRCLE ONE)

(IF YES) What is that?_____

We will be calling some people later by phone to ask a few more questions concerning BART. Could we have your name and telephone number so we can contact you again; either your home or work number is fine, whichever is more convenient for you. The questions we ask by phone will only take 5 - 10 minutes.

(IF NEEDED) Your response will be used for scientific purposes only. Your name will not be used at all.

NAME:_____ PHONE # (work)_____ (home)_____

AGE: Young Middle-aged Older (CIRCLE ONE) SEX:_____

What is a convenient time to reach you?_____

# BART TRAVELER EXPERIENCE STUDY

## PART II: TELEPHONE INTERVIEW

### Call Record

Telephone number:

_____

Panel:_____

Respondent number:_____

Name:_____

| Date Called | Time | Result |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

RESULT CODE (ADD COMMENTS IF NECESSA

Successful completion. . . . . .
Unsuccessful:
No contact after __ attempts . . .
Incorrect number, unable to locate . . . . . .
Contacted, refused . . . . . .
Partial completion . . . . . .
(DUE TO:_____

INTRODUCTION: (FOLLOWING CONTACT WITH CORRECT PERSON)

Hello, my name is _____ and I'm calling on behalf of the BART Impact Program. You probably remember giving us your name while you were taking a trip on BART. I would like to ask you a few questions about your experiences as a BART rider, to help us in our study of the BART system.

(IF NEEDED) Let me ask you some questions first and then we'll have a discussion.

(IF NEEDED) The purpose of the study is to help in the design of future transit systems as well as improvements to BART, by identifying both the good and bad things that travelers notice about the BART system when they're using it.

(IF NEEDED) The study is being done for the Metropolitan Transportation Commission, a state agency. The firms doing this study are De Leuw, Cather & Company and Curtis Associates, who are planning consultants.

(IF NEEDED) We have picked BART users randomly to be in several groups of different types of riders. You have been chosen as part of a group of _____ to try to find out how BART meets the needs and preferences of people who use the system for purposes such as yours.

(IF NEEDED) My questions usually take 10 minutes or so, although of course it varies a lot. Is this a good time for you, or should we make an appointment for another time?

DATE:_____ TIME:_____

1. All of my questions will be about your own experience in traveling by BART. First I need to know something about your use of BART, so that we'll know how to match your experience with others. About how many round trips do you make on BART in a typical week?

NUMBER: _____ ROUND TRIPS PER WEEK

OR OTHER RESPONSE: _____

_____

2. And from what BART station do you make most of these trips?

NAME OF STATION: _____

OR OTHER RESPONSES: _____

_____

3a. And to what BART station do you usually travel?

NAME: _____

OR OTHER: _____

b. Do you usually make a transfer from one BART train to another? Yes_____

No _____

c. (IF YES) At what station do you usually transfer?

(CIRCLE ONE) MacArthur 19th Street 12th Street

Other: _____

4. At about what times of the day or evening do you most often travel on BART?

TIMES: _____

OR OTHER: _____

5. How do you usually get to the station to start these trips?

Walk . . . . . 1
Drive (or ride) and park . . . . . 2
Dropped off by car . . . . . 3
Bus . . . . . 4
Other (EXPLAIN). . . . . 5

_____

_____

6. At the other end of these trips, do you usually walk to your destination, take a bus, or what:

Walk. . . . . .1
Bus . . . . . .4
Other (EXPLAIN) . . . . . .5

_____

_____

7. And what is the main purpose or purposes of the trips you make on BART?

_____

_____

8. How did you make this trip before you started using BART?

Walk
Bus
Car
Other: _____

9. During this brief interview I'm going to ask you some questions about different parts of the BART system which you experience when making a typical trip. These include outside the station, inside, on the platform, and on the train itself. I'm interested in everything about the BART trip that's important to you. For instance:

- Is it comfortable for you to use?
- Is it easy and understandable to use?
- Do you feel safe from accident or crime?
- Does it get you where you're going on time?
- Can you get information or help when you need it?
- Does it give you any general interest or enjoyment?
- Anything else that's important to you?

Now let's look at your typical BART trip, step by step.

a. Let's start with your arrival at a station. Considering that you usually come by (car, bus, walking, other), what are the things that you notice most before you are actually inside the station? Be as specific as you can.

(PROBE IF NEEDED) Remember all the things you do and see.

CIRCLE ONE

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

b. Any (other) good things? _____

_____

c. Any (other) bad things? _____

_____

10. Now let's think about what happens after you go inside the stations you use. First, let's consider all that happens to you up to and including getting through the fare gates. Keep in mind all the kinds of things that I told you we were interested in -- things like:

- Is it comfortable for you to use?
- Is it easy and understandable to use?
- Do you feel safe from accident or crime?
- Does it get you where you're going on time?
- Can you get information or help when you need it?
- Does it give you any general interest or enjoyment?
- Anything else that's important to you?

a. What are the things you notice most? (PROBE IF NEEDED) Remember all the things you do and see.

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

b. Any (other) good things?_____

_____

c. Any (other) bad things?_____

_____

11a. As you ascend or descend to a platform, do you usually use an elevator, escalator or stairs? (CIRCLE ONE)

b. Any reason?_____

_____

12a. After reaching the platform you wait for a train. What are the things you notice most about this part of your trip, between the time you put your ticket into the fare gate and when you actually get on the train? (PROBE IF NEEDED) Remember all the things you do and see.

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

b. Any (other) good things?_____

_____

c. Any (other) bad things?_____

_____

13. When the train arrives, you board it and ride to your destination. Once again, keep in mind the kinds of things we mentioned earlier:

- Is it comfortable for you to use?
- Is it easy and understandable to use?
- Do you feel safe from accident or crime?
- Does it get you where you're going on time?
- Can you get information or help when you need it?
- Does it give you any general interest or enjoyment?
- Anything else that's important to you?

a. What are the things you notice most about boarding and riding on BART trains? (PROBE IF NEEDED) Remember all the things you do and see.

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

_____ Good/Bad

b. Any (other) good things?_____

_____

c. Any (other) bad things?_____

_____

14. So far we've talked about going into the stations and riding on the trains. Is there anything else you notice as you leave the BART train and station at the end of the trip?

No. . . . . 1
Yes (EXPLAIN) . . . . . 2

_____ Good/Bad

_____

_____

15. You know that each station is a little different. Thinking about all the stations you've used, is there anything particularly good or bad about any of them?

_____

_____

_____

Anything else?_____

_____

16. Now try to remember back to when you first started using BART. Where did you get most of your information about how to use the system? (CHECK ONE) Was it the station agents, maps, BART brochures, the BART telephone information service, your friends, or something else?

___ Station Agents

___ Maps and other displays in the stations

___ BART brochures

___ BART telephone information service

___ Friends

___ Other (SPECIFY)

_____

_____

17. Now that you are more familiar with the system, where do you get most of the information you need about using BART?

___ Same as before

___ Don't need any

___ Other (SPECIFY)

_____

_____

18. Now just a few questions to sum up your feelings.

a. Overall, what do you like the most about traveling on BART?_____

_____

_____

b. Any other especially good things?_____

_____

19a. And all things considered, what do you dislike the most about traveling on BART?_____

_____

b. Any other especially bad things?_____

_____

20. Now, considering everything, good and bad, how satisfied are you with traveling on BART? Are you very satisfied, fairly satisfied, fairly unsatisfied, very unsatisfied? unsatisfied?

___ Very satisfied

___ Fairly satisfied

___ Neutral (USE ONLY IF RESPONDENT CAN'T DECIDE)

___ Fairly unsatisfied

___ Very unsatisfied

21. How would you rate your overall experience of using BART in comparison to making the same trip by:

a. Bus: Would you say BART is very much better, somewhat better, somewhat worse, or very much worse?

b. And how about in comparison with traveling by car? Would you say BART is very much better, somewhat better, somewhat worse, or very much worse?

| | BART Very Much Better | BART Somewhat Better | Same | BART Somewhat Worse | BART Very Much Worse |
|---|---|---|---|---|---|
| BUS | _____ | _____ | _____ | _____ | _____ |
| CAR | _____ | _____ | _____ | _____ | _____ |

22. We're just about done. Is there anything else you'd like to say about traveling on BART?_____

_____

_____

23. In order to know how to interpret your answers along with those of other people, we need to know your age.

_____ YEARS

Thank you very much for your assistance. You've been very helpful.

END

# APPENDIX D
# PERSONS CONTACTED DURING STUDY

APPENDIX D

LIST OF PROFESSIONALS CONTACTED/INTERVIEWED DURING STUDY

R. Chan, Mechanical Design Engineer, BART

R. Crist, Lead Mechanical Engineer, BART

S. Emmerman, Resident Engineer, BART

W. Green, Supervisor, Passenger Service Communications, BART

M. Hawley, BART Impact Program Liason, BART

T. Heath, Foreman, Elevator/Escalator Repair and Service, BART Plant Support Division

C. Herose, Passenger Service Representative, BART

W. McCutchen, Manager of Installations, BART

J. McKissick, Records Division Officer, BART Police

D. Minkus, Assistant Project Director, Jefferson Associates

B. Newlon, Traffic Officer, BART Police Services

B. Newstadter, BART Planner, BART

R. Rypinski, Supervisor, Maintenance Planning Department, BART

D. Soblin, Public Information Officer, BART

D. Tong, BART Police Officer, BART

G. Wilson, Ph.D., Acoustic Consultant, Wilson Ihrig & Associates, Oakland, California

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  (DOT-BIP-TM 25-4-77)
- Indirect Environmental
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* Document is available to the public through the National Technical Information Service (NTIS), Springfield, Virginia 22151. Other documents are MTC internal working papers.

## STUDY PARTICIPANTS

### Consultant Team

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### Performing Organization

Metropolitan Transportation
Commission

### Sponsoring Organizations

U. S. Department of
Transportation
U. S. Department of
Housing and Urban Development